

TRANSPORTATION DEPARTMENT



RESEARCH REPORT

**Statewide and Sub-area
Transportation Model Feasibility
Study**

**Final REPORT
FHWA-ITD-RP130**

to

Idaho Transportation Department
Boise, Idaho

by

Zaher Khatib, Ph.D
Karl Chang, Ph.D
Yanmei Ou
Monica Bielenberg

National Center for Advanced Transportation Technology
University of Idaho
Moscow, ID 83844-0901

12/30/97

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave Blank)

2. REPORT DATE

12/30/97

3. REPORT TYPE AND DATES COVERED

Final

4. TITLE AND SUBTITLE

Statewide and Sub-area Transportation Model Feasibility Study

5. FUNDING NUMBERS

6. AUTHOR(S)

Zaher Khatib, Ph.D; Karl Chang, Ph.D; Yanmei Ou; & Monica Bielenberg

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(ES)

University of Idaho

National Center for Advanced Transportation Technology

BEL 103

Moscow, ID 83844-0901

8. PERFORMING ORGANIZATION
REPORT NUMBER

97-14-01

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Idaho Transportation Department

Post Office Box 7129

Boise, ID 83707 - 1129

10. SPONSORING / MONITORING
AGENCY REPORT NUMBER

FHWA-ITD-RP130

11. SUPPLEMENTAL NOTES

Research performed in cooperation with the Idaho Transportation Department and the US Department of Transportation, Federal Highway Administration.

12a. DISTRIBUTION / AVAILABILITY STATEMENT

No restrictions. This document is available to the public through NITS: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

In this research, a feasibility study to develop an Idaho statewide transportation model is conducted. Review of statewide transportation models from Florida, Wyoming, Michigan, Vermont, Indiana, and Pennsylvania is conducted to summarize the most appropriate procedure for developing a statewide model. On the local level, the transportation planning effort in Idaho is reviewed. This effort includes review of the metropolitan planning organization models as well as Idaho commodity flows, which will be the basis for the statewide model. A review of the transportation planning software packages is conducted to select the most appropriate package for statewide modeling. The research team recommends Transplan as the outweighing package for Idaho statewide modeling. A transportation model requires the input of a transportation network, traffic data and land use data. Therefore, the availability of existing digital databases is assessed. This study has constructed the foundation for developing the Idaho statewide travel demand model. On the basis of this feasibility study, ITD will implement phase two of this project, the development of the Idaho Statewide Transportation Model. The proposal for the model is represented in the final section of this report.

14. SUBJECT TERMS

Commodity flow, statewide modeling, Transplan, transportation planning,

15. NUMBER OF PAGES

80

16. PRICE CODE

17. SECURITY CLASSIFICATION
OF REPORT
UNCLASSIFIED

18. SECURITY CLASSIFICATION
OF THIS PAGE
UNCLASSIFIED

19. SECURITY CLASSIFICATION
OF ABSTRACT
UNCLASSIFIED

20. LIMITATION OF ABSTRACT
SAR

TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
LITERATURE REVIEW	3
INTRODUCTION TO STATEWIDE PLANNING.....	3
URBAN VS. STATEWIDE TRANSPORTATION PLANNING.....	3
STATE-BY-STATE MODEL STUDIES	4
<i>Florida</i>	4
<i>Wyoming</i>	6
<i>Michigan</i>	7
<i>Vermont</i>	8
<i>Indiana</i>	8
<i>Pennsylvania</i>	8
SUMMARY OF THE STATE-BY-STATE STUDIES.....	9
<i>Data Requirements</i>	9
<i>Concerns</i>	10
<i>Advantages</i>	10
METROPOLITAN TRANSPORTATION PLANNING IN IDAHO.....	12
BENCH/VALLEY TRANSPORTATION STUDY	12
CITY OF POST FALLS TRANSPORTATION STUDY	13
COMMODITY FLOW IN IDAHO	14
SOFTWARE REVIEW	18
TRANSCAD.....	18
TRANPLAN.....	18
TRIPS	18
EMME/2	18
MINUTP.....	19
TMODEL2.....	19
QUICK RESPONSE SYSTEM II (QRS).....	19
THE HIGHWAY EMULATOR (THE)	19
TEXSIM TRAFFIC NETWORK SIMULATION MODEL.....	20
SYSTEM II.....	20
DYNVIMTS	20
SMARTPATH SIMULATION AND ANIMATION PACKAGE.....	20
EXISTING DIGITAL DATABASES FOR A STATEWIDE MODEL	21
MILEPOST AND CODED SEGMENT DATABASE	21
TRANSPORTATION NETWORK DATA.....	22
TRAFFIC DATA	24
LAND-USE DATA.....	26
IDAHO STATEWIDE TRAFFIC DEMAND MODEL	27
RESEARCH PROBLEM STATEMENT.....	27
THE DEVELOPMENT OF IDAHO STATEWIDE TRANSPORTATION MODEL.....	27
<i>Basic Model Components</i>	27
<i>Software</i>	28
<i>Data</i>	28

USE OF GIS	29
INTERACTION BETWEEN THE STATEWIDE MODEL AND THE METROPOLITAN AREA MODELS.....	29
SCOPE OF WORK.....	30
JUSTIFICATION FOR THE PROJECT	32
PROJECT BUDGET	32
REFERENCES	33
APPENDIX A. MAPS.....	37
APPENDIX B. TRANSPORTATION SOFTWARE REVIEW	53
APPENDIX C. CONVERSION OF THE ITD HIGHWAY CENTERLINE DATABASE TO AN ARC/INFO COVERAGE AND THE INPUT DATA FILES FOR TRANPLAN	65
APPENDIX D. EXAMPLE OF STATEWIDE TRAFFIC DEMAND MODELING USING TRANPLAN	70
APPENDIX E. PROCEDURE FOR TRIP GENERATION	78

Executive Summary

The Planning Division of the Idaho Transportation Department is seeking to develop a PC based statewide transportation model. The main objectives of the model are: to facilitate statewide and regional transportation planning, to support decision making on environmental concerns, and to support the data requirements of the Pavement Management System (PMS) and the Highway Performance Monitoring System (HPMS). The statewide travel demand model will provide 5, 10, 15, and 20-year forecasts.

Currently, the Idaho Transportation Department (ITD) uses historically based trend models to forecast 20-year design-hour volumes for the design and analysis of proposed roadway projects. However, ITD planners realize that this trend forecasting method has serious limitations. They would like to develop a procedure that is more theoretically based, similar to the standard four-step travel demand forecasting process that is often used in urban areas. They also want to integrate the statewide model with existing Transportation Planning Models used by the Metropolitan Planning Organizations (MPOs) in Idaho, e.g., Boise metropolitan area, Pocatello urbanized area, and Idaho Falls urban area.

Development of the statewide travel demand model is a two-phase process. Phase 1 is a feasibility study, which identifies existing needs in data requirements and computer hardware and software. Phase 2 is model development, which involves the actual development of the model and training of Idaho Transportation Department personnel as the potential users.

This report summarizes the Phase 1 feasibility study. The report includes the following topics:

1. **Review of statewide transportation models from Florida, Wyoming, Michigan, Vermont, Indiana, and Pennsylvania.** This section details the procedures and steps that each state undertook to develop their own statewide models. A summary of the most appropriate procedure for developing a statewide model concludes the section.
2. **Review of transportation planning efforts in the state of Idaho.** This section reviews technical reports from a Metropolitan Planning Organization and a small urban area in Idaho. Other metropolitan organizations are still in a development stage and only have traffic analysis zone maps.
3. **Commodity flow.** It is important to obtain information on the flow of commodities in and through the state. This information serves two purposes: to estimate the external station truck flow, and to estimate the in-state truck flow.
4. **Review of transportation planning software.** This section reviews transportation planning software packages to determine their suitability for adoption for the Idaho statewide model. The study recommends TranPlan or TransCAD, two leading packages

in the field. The vendors of these two packages demonstrated their products on September 10-11, 1997 at the Owyhee Plaza Hotel, Boise, Idaho.

5. **Existing digital databases.** A transportation model requires the input of a transportation network, traffic data, and land-use data. Therefore, one of the first steps in transportation planning is to assess the availability of digital databases. This section reviews the following data sources: the Idaho Transportation Department Milepost And Coded Segment (MACS) database, the National Transportation Atlas Database 1996, the 1990 Census Transportation Planning Package (CTPP), State Summary Commodity Flow Survey (CFS), American Travel Survey (ATS), Federal Highway Administration's Nationwide Personal Transportation Survey (NPTS), the Bureau of Transportation Statistics' Transborder Surface Freight Data Set, and the U.S. Census Bureau for land-use data. To investigate the transportation network data sources and availability, data provided by ITD were compared with data from other sources. The GIS software ARC/INFO was used for this comparison.
6. **Proposal for a statewide model.** The last part of this report includes a proposal for developing the Idaho Statewide Traffic Demand Model. This proposal includes the tasks that will be undertaken over a two-year period.

Appendices to this report include: a detailed software review, the process of converting the ITD Highway Centerline database to an ARC/INFO coverage, an example of an Idaho statewide traffic demand model using TranPlan, and a procedure to develop a trip generation table. These supporting materials are intended to clarify issues related to the development of the statewide demonstration model.

Finally, it should be noted that the software packages used in the feasibility study are simply tools to build a demonstration version of the Idaho statewide model. ITD needs to make a decision on which packages to use for the statewide model. However, the University of Idaho feasibility study software review ranks TranPlan and TransCAD above other packages. These software packages are also used by most states. The University of Idaho research team recommends TranPlan to be used for the Idaho statewide model.

In summary, this phase 1 study demonstrated the feasibility of developing an Idaho Statewide Travel Demand Model. The Idaho Transportation Department has most of the data needed for the model development (see section 5). Furthermore, the University of Idaho research team confirmed the capability of developing the statewide model, as presented in this report (e.g., Appendix D).

Literature Review

Introduction to Statewide Planning

Before 1991, twenty-three of the states in the U.S. had started or completed statewide future year plans. But with the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, every state is now required to create and implement a statewide transportation plan that has the ability to be updated annually. Because of this Act, many states are now revising older, more traditional transportation plans.

Historically, statewide planning has been urban orientated and emphasized only one major mode of transportation, the passenger car. ISTEA's purpose is to broaden transportation planning to encompass multimodal planning of the movement of people and goods. ISTEA also heavily emphasizes addressing the environmental concerns of today's transportation systems in planning. Reaching these goals will be possible by utilizing current management systems in decision making, involving the public and local officials in the decision-making process, and expanding the roles of Metropolitan Planning Organizations (MPOs). Through the requirements of ISTEA and the effort of states, statewide planning will provide a more efficient and cohesive transportation system, not only at the state and local level, but also at the national level.

Urban vs. Statewide Transportation Planning

The older traditional models were reliable when used in Urban Transportation Planning (UTP). In order to apply them to Statewide Transportation Planning (STP), many states took similar steps in updating them. The first step was to simplify the models. For the models to be applicable on a statewide level versus an urban one, they had to have the ability to encompass many more variables. The second adaptation was the use of computers in the modeling system. Through the use of programs such as GIS, models became more powerful and flexible. The third most common adaptation was the introduction of multimodal programming. With the use of these models for statewide planning, many more modes of transportation were required to be considered. These new modes include railway, water ports, and airports.

Once a state decided how they would approach the statewide planning process, it created guidelines to follow and objectives to attain. To generate highway improvements that lead to greater benefits, three common guidelines were set:

1. Design for system continuity and balance between state and local levels.
2. Seek low-cost design alternatives.
3. Maximize benefits and minimize costs.

The objectives most commonly set were to provide an early-warning system that would be accessible and accountable for all levels of use.

After this point, states continued the process in various ways and created very diverse models. For most, UTP modeling was the starting point to achieve a STP model. To achieve this changeover, they had to look at issues facing statewide transportation decision-makers.

The following is a compilation of concerns states face when making statewide transportation decisions:

1. Concern for the environment
2. Changing economy
3. Changing urban transit options
4. Increasing difficulty in financing highway maintenance
5. Changing nature of air and rail travel

Taking these concerns into account will result in a STP reflecting an integrated and unified transportation system on all levels.

State-by-State Model Studies

Florida

Florida's original statewide transportation study concluded in 1988. Since that time, it was updated and validated in 1990, 1993, and 1994. The purpose of the study was to develop a useful and straightforward process for forecasting statewide travel on Florida's network system. Statewide forecasts were made for travel outside the urbanized areas, including intercity travel. Florida's model used traditional methods of urban transportation planning (UTP) on a statewide level.

The first step taken in Florida's analysis was the development of Traffic Analysis Zones (TAZs). In creating the TAZs, three systems were utilized. Traffic analysis zones previously defined by the MPO's were analyzed first, then the Census boundaries, Census Tracts and Enumeration Districts, and lastly the System of Public Land Surveys. AutoCad was employed as the mapping software and was found to be flexible and easily revisable in the TAZ formulation process. AutoCad was also used in other areas of the modeling process, as well as MARKNET.

Many features of the Florida statewide transportation model originated from their urban transportation model. This is clearly evident in the development of the Trip Generation Model. The trip purposes indexed were 1) Home-Based Work, 2) Home-Based Shopping, 3) Home-Based Social-Recreational, 4) Home-Based Miscellaneous, 5) Non-Home Based, and 6) Truck/Taxi. The sources of socioeconomic data were 1) urbanized area socioeconomic data, 2) urbanized area productions and attractions, 3) U.S. Census data, 4) Florida Statistical Abstract, and 5) tax assessor's data. By beginning with urban trip generation, a familiar and well-documented procedure, Florida was able to incorporate rural trip generation and finally external trip generation into their model with greater ease.

In the trip distribution phase, as common to most states, the Gravity Model was used. The friction and K factors were developed during the validation phase. In the trip assignment phase, three issues were found to be of concern which were 1) the time of year, 2) the period of the day, and 3) the type of model. The statewide model was developed in a microcomputer environment, where UROAD, an iterative equilibrium model, was used for the process of trip analysis.

Data requirements for transportation supply include:

1. Highway links representing segments of roadways.
2. Cartesian coordinates describing the geographic locations of the nodes and links.
3. Data describing the characteristics of each highway link: distance, travel time and/or speed, tolls, county or other geographic location data, area type, facility type, number of lanes, existing traffic count, capacity, screenline, and roadway name.

Data requirements for travel demand include:

1. Socioeconomic and demographic data: population, dwelling units, auto ownership, school enrollment, place-of-work employment by type, or SIC code.
2. Mapping data: a reference system of Cartesian coordinates, outline of Florida, county boundaries, zone boundaries and centered locations and county names and centroid numbers.

Although the Florida statewide model was operational in 1990, it was not producing accurate traffic estimates. The key issues of validation in the model are the highway networks and model parameters.

Recommendations from the report are:

- Zones that cross county lines should always be split to represent different socioeconomic and travel behavior characteristics.

- A rural area travel characteristics study should be conducted to identify any purpose when compared to urban area trip rates.
- Consideration should be given to modifying the facility types and area types used in the statewide model.

Although the state of Florida is far larger than the state of Idaho in population and extent of its transportation system, Idaho's approach in creating a statewide model will be similar.

Wyoming

Wyoming's statewide model began with the investigation of their statewide transportation planning needs. Based on socioeconomic characteristics, the model focuses on the movement of goods and tourists. Traffic counts were used as primary input. A case study was performed in southeast corner of the state, the location of the state capital and the University of Wyoming.

As in the Florida model, Wyoming's approach was to first create TAZs. In doing so, they created several criteria. The TAZs needed to be small enough to be accurate, yet large enough to reduce data collection efforts. Attention should be paid in keeping the TAZs consistent with jurisdictional areas and census blocks. And finally, TAZ sizes must be sufficient enough to conduct intermodal analysis.

Several different computer programs were used in the Wyoming model. The planning network was built with the Window's-based General Network Editor (GNE). To process input data and perform the interactive segmentation procedure, Excel 5.0 with a Macro written in the Microsoft Excel Implementation of Microsoft Visual Basic Programming System was used. After the Origin-Destination (O-D) tables were created using the Entropy Maximization Model, they were entered into the Visual Basic EM model program. Trip assignment proportion matrices were produced with the Quick Response System II (QRSII). For future year O-D table predictions, the Fratar model was used and programmed with the Visual Basic language.

Because Idaho has socioeconomic and geographic conditions similar to those of Wyoming, their modeling procedures may be suitable for our intended use. Three suggestions are made to tailor Wyoming's model to Idaho's needs: 1) incorporating land-use data to make the models more reliable, 2) using GIS in the modeling process, and 3) displaying the results visually to allow a comparison with the land-use data and other transportation data.

Michigan

In 1993, the Michigan Department of Transportation updated their statewide travel demand model and calibrated their existing model. A key focus of the calibration was to review commodity flow modeling with regards to land use. Also examined were the range of approaches to statewide modeling. These approaches included 1) models based on urban transportation theory, 2) models based on analytical procedures, and 3) models based on census type procedures. All three of these approaches, as seen in other statewide models, are commonly used. It was concluded that, although the traditional four-step urban transportation modeling system is somewhat rigid and in some cases simplistic, the Michigan model was the most productive and effective of all the models used by states.

Because it was decided not to change the basic structure of the Michigan model, how to improve the model became the next issue. In order to transform the existing model into one that evaluated a multimodal system, each step of the four-step process had to be reviewed and revised.

In the **trip generation** stage, the following factors would be expected to be included in a multimodal system:

- The generation of Person Trip productions and attractions, including intrazonal trips
- The production model to be based on average trips rates per household cross-classified by household category
- The attraction model to use regression equations based principally on employment categories

For the **trip distribution** stage, the following factors would be expected to be included:

- The model to be conformable with the standard Gravity Model formulation
- The trip distribution to be performed independently for each trip purpose produced by the trip generation model
- The K factors to be capable of handling intrazonal and short/long interzonal trips

For the **mode choice**, these factors would be expected:

- A network that included different carpooling methods
- Trip purposes to be separated according to mode choice

- **Effects of policies** (parking restrictions, commute options, road, bridge, parking and fuel pricing, effects of widened sidewalks, protected cross walks, median removal and insertion, and building setbacks)
- **Management actions** and other transportation control measures
- **Demographic trends** and urban development patterns
- **Use of advanced technologies** (remote sensing, automatic vehicle locating technologies, and global positioning systems)

Concerns

Among the statewide models studied, the following areas need to be addressed for a model to be effective:

- Incorporating the impacts on a **wide range of interests** (e.g., other state facilities)
- Having a broad **range of goals**
- Creating a model that can be matched with **new modes of transportation**
- Having a model that relates to issues stressed by **local officials**
- Creating a model that doesn't require too much maintenance for **easy application**
- Creating base support by maintaining **public involvement**
- Researching **other alternatives** or making the system flexible for other alternatives
- Incorporating **multimodal programming** to some extent
- Correlating **land use** to the system
- Taking trip surveys on **all highways** in the state
- Taking steps towards **implementation** of the model
- Recognizing the inevitable **uncertainties** in the model

Advantages

States that did transform the UTP model towards STP came up with the following advantages to the system:

- **Reduced effort** in forecasting volumes and when to justify a new route
- **Data is easily obtained** to base decisions on relocation of new routes and redirection of travel

- **Classification of roads** became easier
- Aided in **land-use planning problems**
- Helped determine the effects caused by changes in **economic activity**
- Model may be used to **establish priorities** in further studies
- Model may be used to **plan for highway renovations** in poorly developed areas

Metropolitan Transportation Planning in Idaho

The planning of a statewide model must consider transportation planning models that have been developed by the metropolitan planning organizations (MPOs) in the state's urbanized areas and other urban area modeling efforts. Urban areas make up a significant portion of traffic analysis zones (TAZs) in a statewide model. A statewide model, on the other hand, can provide external traffic data to an urban area transportation model. The size and number of the TAZs will most probably coincide with Idaho's six districts and 44 counties since their borders correspond. In areas where more TAZs will be required than provided by the counties or districts, the census tracts will be used. There are 268 census tracts in Idaho. Maps of the counties, districts, census tracts, and major roads in Idaho are provided in Appendix A. Integration of a statewide model and urban area transportation models is therefore important for planning purposes.

Idaho has different levels of planning activities in its urbanized and urban areas. Idaho's three urbanized areas (over 50,000 in population) have Metropolitan Planning Organizations, namely Ada Planning Association, Bannock Planning Organization, and Bonneville Metropolitan Planning Organization. In urban areas (5,000 to 50,000 in population), there are different types of travel forecasting models in place, e.g., Post Falls, Nampa, and Lewiston. For this project, two planning activities (one in an urbanized area and the other in an urban area) have been examined. The following is a summary of urban transportation models for Ada County and Post Falls. Other planning activities in Idaho are in progress of initiating and/or developing travel demand models, e.g., Kootenai County.

Bench/Valley Transportation Study

In 1995, the Ada Planning Association developed its Regional Travel Demand Model and GIS System jointly with Cambridge Systematics, Centennial Engineering, Intermountain Graphics, and Sciencetech. The system combined the software packages of TranPlan, ARC/INFO, SAS, Foxpro, and other utility programs written in the C programming language. The objectives of the study were as follows:

1. To develop a multimodal transportation network based on the existing highway and transit networks.
2. To develop high-quality base year (1993/1994) trip tables by travel mode, trip purpose, and time of the day.
3. To forecast the changes in land use, socioeconomic variables, and travel characteristics for the future year, 2015.

4. To develop the future year network for different alternatives using the base network and the proposed changes in the transportation system.
5. To develop the future year tables by travel mode, trip purpose, and time of day from the base year trip tables using forecasts of land use, socioeconomic, and travel characteristic data changes, transportation network changes, and incremental demand models.
6. To assign the future year trip tables to future year network.

The highway network included 399 TAZs in Ada County: 285 internal, 16 external and 98 dummy zones. Input data for the base year consisted of socioeconomic data, population, households, retail, non-retail, and employment data from the 1990 Census Transportation Planning Package and the 1990 U.S. Census of Population, as well as data from a household travel survey. Input data for the future year were projected based on three density socioeconomic scenarios.

The Bench/Valley Model did not follow the four-step process commonly used in transportation planning. Instead, it involved the development of a detailed set of origin and destination trip tables by mode, purpose, and time of the day.

City of Post Falls Transportation Study

David Evans and Associates, Inc. completed a transportation study for the city of Post Falls in June of 1997. Using the software package TMODEL 2, the study had three objectives:

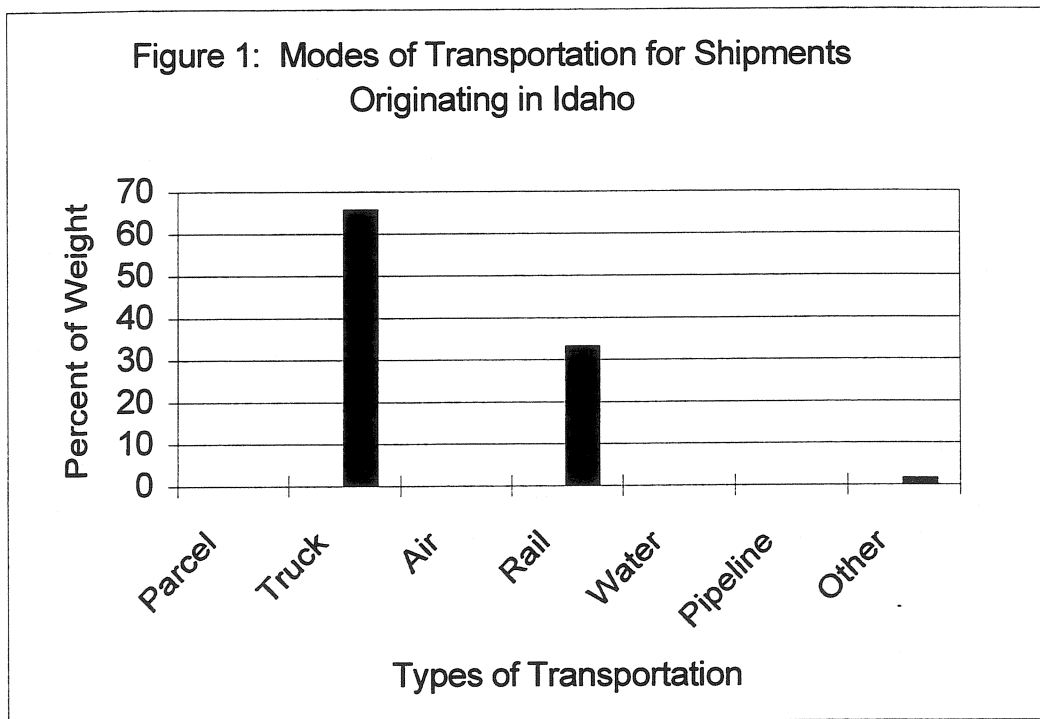
1. To create a transportation model to simulate the current (1995) travel conditions and to forecast the future (2015) traffic.
2. To refine the roadway system as defined in the draft Post Falls Comprehensive Plan, May 1994.
3. To make recommendations for sidewalk and bikeway improvements.

The transportation network included state highways, most county roads, and city streets that were vital to the circulation of traffic. Fifty internal TAZs and eight external zones were defined based on the census blocks, physical barriers, roadway locations, and land-use characteristics. 1990 Census data, including population, households, and employment characteristics provided the basis for the estimated 1995 data and the projected 2015 data used in the model.

The Post Falls study followed a standard procedure of trip generation, trip distribution, trip assignment, model calibration, and future trip assignment.

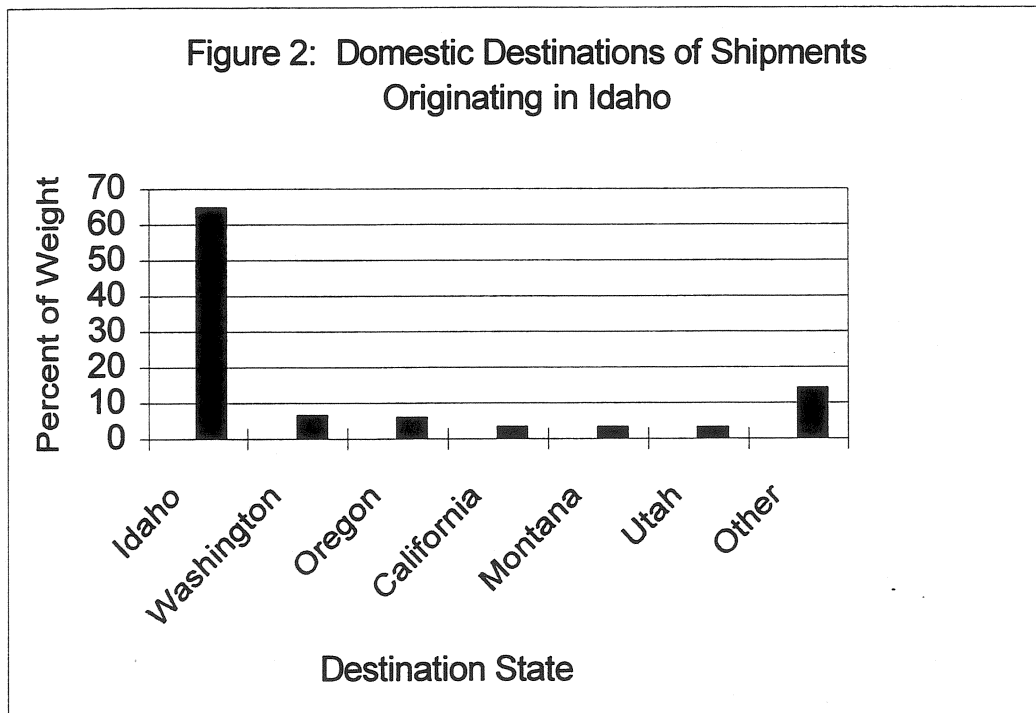
Commodity Flow in Idaho

Prior to the passage of ISTEA, planning in Idaho primarily focused on the local level, incorporating counties and districts. State legislation has required each city and county to create and continually update comprehensive plans. Because of this, there has been some limited involvement in certain levels of statewide planning. These areas encompassed pavement management, safety management, and traffic monitoring. All have successfully incorporated public involvement in their operating systems. Nonetheless, these comprehensive plans were deficient of intermodal considerations, congestion management, and consideration of public transportation.



In an effort to develop an intermodal statewide plan for Idaho, the primary transportation modes used for commodity flows have been researched. In Idaho, approximately 65.5 percent of total weight shipped is done by truck, 33 percent by rail, and 1.5 percent by means of air, water, or pipeline (see figure 1). These shipments originate in Idaho and do not include interstate shipments from other states. (Source: "1993 Commodity Flow Survey State Summaries" published by the U.S. Department of Transportation Bureau of Transportation Statistics in September 1996)

In order to create traffic analysis zones, destinations of shipments originating in Idaho were used. These destinations were viewed in two ways. The first consideration was the state in which the shipment was destined, and the second was the distance that the shipment would travel. According to percent of weight, Washington, Oregon, California, Montana, and Utah are the primary states receiving Idaho commodities (see figure 2). Sixty-four and one-half percent of Idaho's commodities remain within the state. 45.3 percent of Idaho's commodities travels less than 50 miles, 19.4 percent travels only 50 to 99 miles, 8 percent travels 100 to 249 miles, and the remaining percent travel over 250 miles (see figure 3). From this data, an initial trip generation chart was created to simulate commodity origins and destinations (see figure 4).



Because land-use correlation is vital to the validity of a statewide model for future traffic flow predictions, types of commodities shipped in Idaho were reviewed. Currently in Idaho, lumber or wood products, excluding furniture accounts for 42.8 percent of commodities shipped, by weight. Other primary commodities shipped include nonmetallic minerals 14%, farm products 13.3% (e.g., field crops, fresh fruits or vegetables, poultry, livestock and their products), food (e.g., meat, poultry or small game, fresh, chilled, or frozen; canned or preserved fruits, vegetables, or seafood; dairy, grain mill, and bakery

products; beverages) 10.8%, stone products (e.g., clay, concrete, glass) 5.8%, and other commodities account for 13.3% (see figure 5).

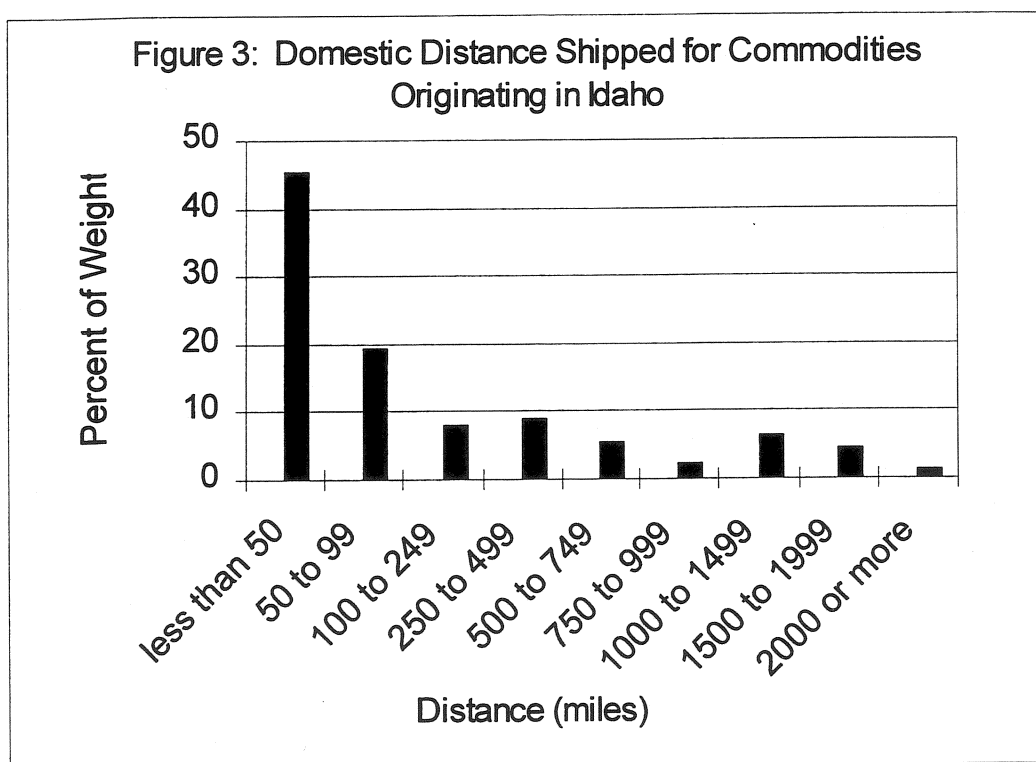
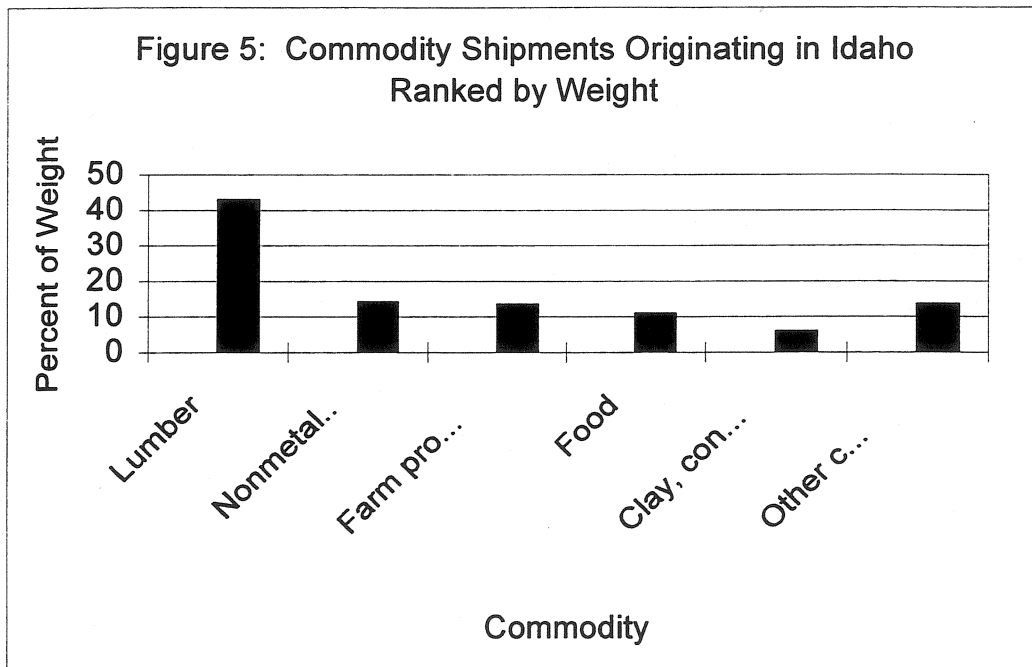


Figure 4: Sample Trip Table

From \ To	ID	CA	WA	OR	UT	MT	Other
ID	64.5	3.2	6.4	5.8	3.0	3.1	14.0
CA	0.0	91.2	0.7	1.3	0.0	0.0	6.8
WA	1.2	4.5	83.8	5.5	0.0	0.0	5.0
OR	0.7	5.7	8.1	80.2	0.0	0.0	5.3
UT	0.9	0.0	0.0	1.1	80.8	0.0	17.2
MT	2.8	0.0	5.9	2.2	0.0	42.2	46.9



Software Review

From the Internet, twelve traffic modeling software programs were found. Six were selected as candidates for Idaho's statewide traffic demand modeling: TransCAD, TranPlan, TRIPS, EMME/2, MINUTP and TMODEL2. The vendors were contacted by telephone, email, or written a letter to request general information, price lists, or demonstration disks. A summarization of this information for these six software packages can be found in Appendix B. A brief introduction for each of the six software programs is as follows. Additional six software packages are presented briefly.

TransCAD

TransCAD was the first PC-based Urban Transportation Planning (UTP) software program to combine a true geographical information system (GIS) with a fully integrated UTP model. TransCAD was also the first UTP program to offer a fully integrated set of menu screens. The network building facility in TransCAD can be quite challenging to master, even for experts.

TRANPLAN

TranPlan is one of the most commonly used PC-based UTP software programs in the US. TranPlan may not be the fanciest program, in terms of offering multiple versions of advance route assignment procedures, but it does provide all of the options normally associated with the traditional four-step UTP process. TranPlan is often favored for areas in which trip estimation and assignment have legal implications or when state planning agencies require standardized model outputs.

TRIPS

TRIPS is a British product, more widely used in Europe than in the USA. TRIPS's primary distinction is its fairly robust dynamic route assignment algorithm, which explicitly considers intertemporal changes in traffic congestion at specific intersections. This makes TRIPS particularly useful for modeling highly congested or saturated flow networks. TRIPS also includes many additional features, which are available at additional cost, but would not satisfy Idaho's modeling needs.

EMME/2

EMME/2 is a Canadian product that is in many respects the Cadillac of UTP software. EMME/2 provides the best documentation of any UTP package, way beyond the usual perfunctory references to the literature. EMME/2 does not include default settings for any procedure, assures that the user should be

able to specify an appropriate model form, and understands what the model represents. EMME/2 is not designed for beginners and is appreciated by more advanced UTP modelers.

MINUTP

MINUTP is based on a variety of UTP utilities developed over the years by COMSIS Corporation in response to client needs. For example, COMSIS recently developed an elasticity-based travel demand management (TDM) evaluation utility for use in conjunction with MINUTP.

TMODEL2

TMODEL2 is one of the older PC-based UTP programs. The program treats networks for different modes separately, assigning mode split prior to trip distribution. The program calculates intersection delays with internal variable formulae, rather than having the delay definitions fixed as constants internally by the modeler.

Quick Response System II (QRS)

QRS II is based on the National Cooperative Highway Research Program Report 187, which outlines the quick response system developed by FHWA for sketch planning and site impact analysis in small urban and rural areas. While QRS II has been greatly expanded since its introduction, it is still mainly a tool for smaller urban transportation planning applications. Because QRS II includes defaults for all model settings based on accepted industry standards, it is perhaps the easiest package to learn and use.

The Highway Emulator (THE)

THE is by far the most basic of programs, providing neither graphics nor training and very little technical support. The program requires relatively little training. Due to the simplicity of the program, it is available for free. Its primary use is for site impact analysis and most often is applied to developments of regional significance in smaller urban areas or in the outlying suburbs of larger cities. This package is one of the few that can be used to develop synthetic origin-destination trip tables based on existing traffic counts. This approach works best when origin-destination data are in place and vehicle counts are available for all or most of the key route segments in the study area.

TexSIM Traffic Network Simulation Model

TexSIM is an advanced multi-modal microscopic traffic component simulation module. TexSIM is being developed by the Texas Transportation Institute (TTI) to research and implement complex signal systems operation under new types of control strategies. TexSIM Simulation Module Version 3.0 currently runs under the Microsoft Windows and Microsoft Windows NT environments.

SYSTEM II

JHK and Associates developed the commercial version of SYSTEM II quite recently. This is the newest UTP model on the market, and is based largely on utilities JHK has developed over many years. SYSTEM II includes some elements of GIS, as well as a variety of fairly new features designed specifically to accommodate its use of subarea focusing and site analysis.

DYNAVIMTS

DYNAmic Visual Micro-macroscopic Traffic Software (DYNAVIMTS) is a simulation software program Virginia Tech developed to evaluate various aspects of the Automated Highway Systems (AHS). This software addresses both microscopic and macroscopic traffic behaviors in multilayer AHS architecture. This multi-platform software has three modules that operate under UNIX and Windows NT, and call Matlab and Arc/Info for additional processing.

SmartPath Simulation and Animation Package

SmartPath is a simulation package for Automated Highway Systems (AHS). The program may be used to understand how an AHS would perform under various control policies in terms of highway capacity, traffic flow, and other performance measures of interest to transportation system planners and engineers. SmartPath can also be used to simulate, test, and evaluate the performance of the designs of different modules and instrumentations, like engine modes, sensors, and communications.

Existing Digital Databases for a Statewide Model

A transportation model requires the input of a transportation network, traffic data, and land-use data. Therefore, one of the first steps in transportation planning is to assess the availability of digital databases. The following is a summary of digital databases from the Idaho Transportation Department (ITD), the U.S. Bureau of the Census, and other sources.

Milepost and Coded Segment Database

The MACS/ROSE (Milepost And Coded Segment/Roadway Segment) System is an evolving database developed at the Idaho Transportation Department. Within the MACS/ROSE system, roadways, and the various categories of attribute data that describe them, are identified and referenced by the *key* attributes in the database—*segment code, mileposts and dates*. Segment codes (arbitrary, six-digit identification numbers) are assigned permanently to the right-of-way (land) upon which the road physically resides. Beginning and Ending Mileposts further identify the length and relative location of the attributes, features and classifications that describe the roadway. Effective and Expiration Dates identify when the road or its descriptive attributes came into existence or ceased to exist.

The MACS/ROSE Database currently resides on the IBM mainframe system, separate from ITD's GIS base map data that is maintained in the Intergraph's MGE environment. ITD plans to use relational database technology and the Intergraph MGE environment to merge the MACS/ROSE database with the GIS base maps. This will create a locationally referenced Integrated Transportation Information System (ITIS). The descriptive attribute data in MACS/ROSE will be related to the base map data via the MACS/ROSE database key.

The 17 active files in the MACS/ROSE database contain many descriptive attributes potentially useful for developing a statewide transportation model. These attributes include: Interchange locations, intersection locations, jurisdictions, boundaries, functional classification, ADT and per cent commercial ADT, federal-aid funding categories, design hour traffic volumes, lane distribution, etc. Attributes specific to the State Highway System—route number, route type, sign type, route direction, business loops and spurs, overlapping routes, national truck routes, etc.—are stored in the State Highway Route Number File.

Transportation Network Data

The highway centerline database maintained by ITD can provide the base network for a statewide model. The database lists the longitude and latitude readings of every 0.1-mile post of all Interstate, U.S., and state highways in Idaho. Table 1 shows an example of the coordinate data. It has a total of 50,766 records. In this study, the ITD highway centerline database is converted to an ARC/INFO coverage and, thereafter, into the input data files required for TranPlan. A detailed description of the conversion procedure is provided in Appendix C. ARC/INFO and TranPlan were used in this feasibility study to demonstrate how assessing data is a vital step in developing a statewide model.

Table 1. The First 11 Records of Coordinate Data File From ITD

RERD NO.	SEGMENT_CODE	MILEHIGHWAY NO.	LATITUDE	LONGITUDE
601,	001010,	0 , 84	, 44.0064025257716,	116.93984648090
602,	001010,	0.1, 84	, 44.0050360137471,	116.93932695686
603,	001010,	0.2, 84	, 44.0036694117377,	116.93880732929
604,	001010,	0.3, 84	, 44.0023028930929,	116.93828785611
605,	001010,	0.4, 84	, 44.0009363711388,	116.93776840834
606,	001010,	0.5, 84	, 43.9995565481996,	116.93733909048
607,	001010,	0.6, 84	, 43.9982028404108,	116.93681109903
608,	001010,	0.7, 84	, 43.9968877459167,	116.93607983847
609,	001010,	0.8, 84	, 43.9955726487808,	116.93534848705
610,	001010,	0.9, 84	, 43.9942576324813,	116.93461729820
611,	001010,	1, 84	, 43.9929425204591,	116.93388613854

The TIGER (Topologically Integrated Geographic Encoding and Referencing) database, developed by the U.S. Bureau of the Census and the U.S. Geological Survey (USGS) for the 1990 census, is a comprehensive GIS database at street level. The database was created by combining the Census Bureau's GBF/DIME files for urban areas and the 1:100,000-scale USGS quadrangle maps. It includes political boundaries, statistical area boundaries, and line features such as roads, railroads, and rivers. For this project, the ITD database was used to create the initial network and used the TIGER database to add more links to the network. The TIGER database, because it contains blocks, census tracts, and enumeration districts, is also a good data source for creating traffic analysis zones.

The 1996 National Transportation Atlas Database, produced by the Bureau of Transportation Statistics, U.S. Department of Transportation (USDOT), is a geographic database of transportation facilities. Originally designed to meet the needs of the U.S. Department of Transportation at the national level, the database also has major applications at the regional, state, and local levels. The database includes the geo-spatial information for transportation modal networks, intermodal terminals, and political and statistical areas with related attribute information. Transportation terminals are represented as points

(nodes), transportation networks and services as lines (links), and the geographic references as either points or polygons. In this study, the Idaho highway network was extracted from the database and converted to an ARC/INFO coverage. Table 2 shows the ARC attribute table of the coverage. This network was used as a reference.

Table 2. Attribute Data of Highway Network From NTAD96

FNODE#	=	3
TNODE#	=	1
LPOLY#	=	0
RPOLY#	=	0
LENGTH	=	0.233
CDHIGH#	=	1
CDHIGH-ID	=	20227
LINKID	=	20227
LRECTYPE	=	L
LVERSION	=	02
LREVISION	=	02
LMODDATE	=	0
FEATURID	=	16000538
ANODE	=	16000003
BNODE	=	16000002
DESCRIPT	=	
STFIPS1	=	16
STFIPS2	=	
RECTYPE	=	T
VERSION	=	02
REVISION	=	02
MODDATE	=	0
SOURCE	=	U
STFIPS	=	16
CTFIPS	=	21
ORNL_ID	=	16002540
LGURB	=	0
SMURB	=	0
SIGN1	=	U95
SIGN2	=	
SIGN3	=	
MILES	=	15.48
KM	=	24.92
FACTYPE	=	2
TOLL	=	0
LANES	=	2
ACONTROL	=	3
MEDIAN	=	2
SURFACE	=	1
FCLASS	=	2
ACCLASS	=	P
RU_CODE	=	1
STATUS	=	1
NHS	=	7
STRAHNET	=	0
TRANSAM	=	0

Traffic Data

Traffic data is available from ITD for traffic demand modeling in Idaho. Every highway in the centerline database is divided into segments, and its beginning and ending mileposts specify every segment. Speed limit, functional class, capacity, and annual average daily traffic were obtained from this file. Using the segment code as the relative item, every highway segment was associated with its traffic data (Table 3). ITD has other traffic data, which can be utilized for model evaluation and calibration in the next phase.

Table 3. The First 11 Records of Attribute Data from ITD

SEGMENT_CODE	BEGINNING_MP	ENDING_MP	FUNC_CLASS	SPDLMT	CAPACITY	AADT
001010,	0.000,	5.968,	1,	065,	4147,	13000
001010,	5.968,	12.610,	1,	065,	4021,	13000
001010,	12.610,	17.640,	1,	065,	4021,	13000
001010,	17.640,	24.839,	1,	065,	4021,	13000
001010,	24.839,	25.991,	1,	065,	4147,	20000
001010,	25.991,	26.343,	1,	065,	4147,	25949
001010,	26.343,	26.700,	1,	065,	4147,	26000
001010,	26.700,	27.621,	11,	065,	6533,	28771
001010,	27.621,	27.893,	11,	065,	4251,	30000
001010,	27.893,	28.466,	11,	065,	4251,	30000
001010,	28.466,	32.640,	11,	065,	4251,	34590

The 1990 Census Transportation Planning Package (CTPP) CD-ROM is a set of special tabulations of 1990 census data tailored to meet the data needs of transportation planners. The 1990 CTPP is a continuation of the program established for the 1970 census and continued for the 1980 census in the same general format. Statewide tabulations provide the following data: characteristics of persons, workers, and housing units; characteristics of workers; and characteristics of workers in journey-to-work flows. The area units for data collection are county (places of 2,500 or more) and county subdivision of residence. These data are useful for intercity trip generation in traffic demand modeling.

The State summary Commodity Flow Survey (CFS) identifies where and how goods are shipped in the United States. It lists the value and weight of commodities shipped by manufacturing, mining, wholesale trade, and selected retail and service industries. The survey was a collaborative project between the U.S. Department of Transportation's Bureau of Transportation Statistics (BTS) and the U.S. Bureau of the Census. The Census Bureau collected quarterly data in 1993, as part of its Economic Census, under the technical guidance of BTS. From a sample of 200,000 establishments, commodity flows were estimated for a universe of approximately 800,000 businesses. Data from the CFS for each state include: mode of transportation; total modal activity, mode of transportation and distance shipped, mode of transportation and shipment size, commodities shipped, commodity and mode of state of destination, state of destination

and mode of transportation, state of destination and commodity and shipment, and commodity and distance shipped. Data from the CFS have been used for a variety of freight studies including: national and state freight origin and destination analysis, freight mode split, market-share analysis, and freight planning and management.

The American Travel Survey (ATS) was conducted from January through December 1995. Based on quarterly interviews of approximately 80,000 households in the United States, the survey measured interstate and intermetropolitan passenger travel nationwide by trip and traveler characteristics for all modes and for intermodal combinations. The survey data was released in summer 1997 on CD-ROM, on-line via the Internet, and in printed format.

The Federal Highway Administration's Nationwide Personal Transportation Survey (NPTS) compiles national data on the nature and characteristics of personal travel by all modes of transportation. Information from a national household sample was collected about all trips taken during a designated 24-hour period (travel day). Additional details were collected for trips of 75 miles or farther (one-way) that were taken during the proceeding 14-day period (travel period) including the 24-hour travel day. Available for 1983 and 1990, the NPTS provides the following data: household vehicle availability and use, annual miles per licensed driver, household travel rates, day-of-week and time-of-day travel, vehicle occupancy, and home-to-work trips.

The Bureau of Transportation Statistics' Transborder Surface Freight Data Set (TSFDS), available since April 1993, includes freight flow data by commodity type and by surface mode of transportation (rail, truck, pipeline or mail) for U.S. exports and imports from Canada and Mexico. The data are processed and summarized for BTS by the U.S. Census Bureau on a monthly basis. The Transborder Surface Freight data set provides previously unpublished surface transportation data (other than air or maritime vessel) for U.S. import and export trade with or through Canada and Mexico. The data set includes two sets of tables, one is commodity based, while the other provides geographic detail. The source data for imports and exports are the administrative trade records required by the U.S. Departments of Commerce and Treasury. An increasing amount of import and export statistical information is now available electronically. For imports from Canada and Mexico, approximately 95 percent of the value of those imports are collected electronically. For exports to Mexico, approximately 55 percent are collected through the Automated Export Reporting Program where data are filed directly with the U.S. Census Bureau. The remainder of the Mexican exports is collected from paper documents that are filed with the

Idaho Statewide Traffic Demand Model

In this section, details for developing a statewide model for Idaho and a proposed work plan for the next phase will be discussed.

Research Problem Statement

The purpose of this project is to develop a theoretical model based on the standard four-step travel demand forecasting process that is commonly used in transportation planning. The University of Idaho research team determined that the currently used historically based trend model has serious limitations for planning purposes. In addition to the model's use for planning, this project also serves two other purposes: to assist decision-makers in assessing environmental issues related to transportation, and to support the data requirements of the Pavement Management System (PMS) and the Highway Performance Monitoring System (HPMS). The statewide travel demand model will be developed to provide 5, 10, 15, and 20 year forecasts.

One main aspect of this project, which has not been emphasized in other studies, is the integration of geographic information system (GIS) with traffic demand modeling software. GIS is an efficient tool for preparing the necessary data for trip generation and for data display. The University of Idaho research team will also develop the user interface so that the Idaho Transportation Department's transportation planners can easily take advantage of the MGE.

The Development of Idaho Statewide Transportation Model

Basic Model Components

The standard four-step travel demand process includes trip generation, trip distribution, mode split, and trip assignment. The University of Idaho research team will follow this same process in developing the statewide travel demand model; however, they will make the following changes based on our review of models developed in other states.

1. The Idaho transportation planning model will address intercity passenger and freight flows.
2. The model will include trip generation purposes of home-based work, home-based shopping, home-based school, home-based other, non home-based, recreational, vacation, and truck.
3. The model will use 1995 as the base year, and 2020 as the future year.

4. The model will integrate the components of trip generation and mode split. Trip generation will be processed for each trip purpose and each mode. The model will use the cross-classification method to produce home-based trip production, and linear regression models to produce non-home based production and attractions. The study will derive truck trips from traffic counts, and trip rates and regression coefficients from household surveys.

Software

The University of Idaho feasibility study software review ranks TranPlan and TransCAD above other packages. These software packages are also used by most states. The University of Idaho research team recommends TranPlan to be used for the Idaho statewide model.

Data

Existing data sources

1. The highway central-line database maintained by the Idaho Transportation Department provides the base network for the traffic demand modeling process. The traffic counts in the database can be used for model refinement and validation.
2. The 1995 TIGER Line Files can be used to add more links to the base network and to define traffic analysis zones.
3. The Census CD-ROM offers demographic and socioeconomic data for trip generation.
4. The 1995 American Traveler Survey (ATS) will be a useful data source for intercity trip generation. The survey measures intercity passenger flows by all modes, and provides data on trip and traveler characteristics.
5. Intercity passenger trip information is available from the statewide Census Transportation Planning Package (CTPP).
6. The primary source of data for the truck trip will be the 1993 Commodity Flow Survey (CFS).
7. The National Transportation Atlas Database 1996, produced by the Bureau of Transportation Statistics, U.S. Department of Transportation, includes geospatial information for transportation modal networks and intermodal terminals and related attribute information. The database can be used as a reference for the highway network and its attributes.

Data to be collected

1. A household Origin-Destination survey is needed to derive trip production rates, regression equations for trip generation, and other trip characteristics.
2. An external station roadside survey is needed for the external trip generation information. The study team recommends collecting origin-destination data using the handout/mail-back postcard technique.

3. A roadside survey is needed for truck trip data.
4. Land-use forecasting is needed for future trip generations. In traffic demand forecasting, land use is typically represented by demographic and socioeconomic variables such as population, dwelling units, income, and employment. The input of future land-use patterns and related socioeconomic variables are critical to traffic demand forecasting. An earlier study by Boise State University's, Department of Economic on land-use forecast is already out-of-date. A new land-use-forecasting model is needed for statewide transportation planning.

Use of GIS

The use of GIS in the transportation planning process will make a major difference from the traditional planning models. GIS is an efficient tool for linking land use with traffic demand models. The University of Idaho research team plans to use GIS for the following tasks in the transportation planning process:

1. To Geocode and compile trip origins and destinations from surveys.
2. To capture, store, and manipulate socioeconomic data used in transportation planning.
3. To create and edit the highway network and traffic analysis zones.
4. To display the output from the traffic demand modeling.

A user-friendly interface will be developed to facilitate data exchanges between GIS and transportation planning software packages. In order to maintain compatibility with the GIS group within ITD, Intergraph MGE will be the proper software package to be utilized for the data analysis.

Interaction between the Statewide Model and the Metropolitan Area Models

Major urbanized areas in Idaho have developed, or are developing metropolitan area transportation models. The statewide model complements these metropolitan area models. The intercity flows produced by the statewide model can replace the internal-external and external-external trips in a metropolitan area transportation model. The metropolitan models can, in turn, provide measures of impedance through cities, which are important attributes of the activity nodes in the statewide transportation model. In the future, the statewide land-use and socioeconomic models can provide a consistent basis for estimating growth in the inputs to the trip generation model of metropolitan areas. In the long-term, the statewide model and the metropolitan area models should become fully integrated.

Scope of Work

The following 15 tasks are defined to be accomplished within a 24-month period.

Tasks to be undertaken within the first 12 months:

Task 1 - Define Traffic Analysis Zones

- a. Create county boundary and census tract/block map.
- b. Coordinate TAZ boundaries with county boundary and census tract/block boundary for consistency and facilitating the use of census data.
- c. Locate TAZ centroids and identify external centroids.

Task 2 - Develop Roadway Network

- a. Process the highway central line digital data from ITD.
- b. If necessary, add more links from 1995 Tiger/Line file.
- c. Add centroid connectors
- d. Build trees.

Task 3 - Process Household Origin-Destination Survey Data

- a. Obtain survey data from ITD.
- b. Geocode O-D data.
- c. Factor survey samples to universe.
- d. Create trip records and household characteristics records for trip productions.
- e. Create trip records for trip attractions.

Task 4 - Roadside Survey

- a. Roadside survey for getting information. about external stations
- b. Roadside survey for getting truck trip information.

Task 5 - Establish Trip Generation Model

- a. Evaluate data for cross-classification trip generation model (productions).
- b. Establish household characteristic variables.
- c. Establish trip purpose categories.
- d. Create trip tables (by purpose) from expanded survey data.
- e. Prepare cross-classification matrix for trip productions.
- f. Identify independent land-use activity variables for trip attraction regression analysis.
- g. Apply cross-classification and regression to base year data and check against survey data to validate.

Task 6 - Prepare Distribution Model

- a. Generate trip length distributions from survey data and network travel times.
- b. Develop travel time factors.

Task 7 - Assign Vehicle Trips

- a. Assign generated base year trip tables to base year network.
- b. Compare assigned model volumes to assigned expanded survey data to validate and adjust as necessary to achieve calibration.
- c. Perform screen line/cut line and individual link comparisons.

Task 8 - Integrate the Statewide Model with Existing MPOs' Models

- a. Obtain impedance measures from MPOs' models for the statewide model.
- b. Compare the intercity traffic flows with the internal-external and external-external trips in a MPOs model.

Tasks to be undertaken in the next 12 months:

Task 9 - Verify and Calibrate Base Year Traffic Demand Model

- a. Compare link volumes from assignment to ground counts at strategic locations and on selected screen lines/cut lines.

Task 10 - Develop Land Use Forecasting Model

- a. Forecast changes in socioeconomic variables and travel characteristics for the future year.

Task 11 - Forecasting Future Traffic Demand

- a. Build future year network.
- b. Develop future year trip table.
- c. Assign future year trip table to future year network.

Task 12 - Develop Sub-area Models for each Planning Region Based on the Statewide Model

- a. Identify the needs and requirements of each planning region for the traffic demand model.
- b. Develop sub-area models.

Task 13 - Develop a User-friendly Interface

- a. Identify the needs of exchanging data between GIS and transportation software.
- b. Develop an easier used interface for end users of the statewide model.

Task 14 - Document Procedures and Results

- a. Detail each task and assemble supporting data.
- b. Compile base data files.
- c. Prepare and develop manuals for model applications.

Task 15 - Conduct Training Sessions

- a. Prepare and develop training manuals for model applications.
- b. Conduct training sessions for ITD Personnel.

Justification for the Project

The passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 requires every state to create and implement a statewide transportation plan that can be updated annually. The University of Idaho Civil Engineering Department conducted the Statewide and Sub-area Transportation Model Feasibility Study. They have reviewed models developed for the states of Florida, Wyoming, Michigan, Vermont, Indiana, and Pennsylvania, and also, various transportation planning software packages. This project, which is a follow-up of the feasibility study, proposes to develop a PC-based statewide transportation model to be used by the Planning Division of the Idaho Transportation Department.

Project Budget

Duration of the project: twenty-four months

Budget Item/Year	Requested ITD Funds	UI Match	Total Project Funds
Faculty salaries	\$ 25,120	\$ 10,231	\$ 35,351
Other salaries	\$ -	\$ -	\$ -
Student salaries	\$ 18,072	\$ -	\$ 18,072
<i>Total salaries</i>	\$ 43,192	\$ 10,231	\$ 53,423
Fringe benefits	\$ 7,880	\$ 2,916	\$ 10,796
Operating expenses	\$ 2,000	\$ -	\$ 2,000
Travel	\$ 3,000	\$ -	\$ 3,000
Capital costs	\$ 3,500	\$ -	\$ 3,500
<i>Total direct costs</i>	\$ 59,572	\$ 13,147	\$ 72,719
<i>Indirect costs</i>	\$ 11,914	\$ 5,811	\$ 17,725
<i>Waived indirect costs</i>	\$ -	\$ 14,416	\$ 14,416
Project budget (Year 1)	\$ 71,486	\$ 33,374	\$ 104,860

Total project budget (2 Years)	\$ 142,973	\$ 66,748	\$ 209,720
---	-------------------	------------------	-------------------

REFERENCES

Balloffet and Associates, Inc., Examples of Statewide Transportation Planning Practices, U.D. DOT, FHWA, January 1995.

Barton-Aschman Associates, Inc., A Research Process for Developing a Statewide Multimodal Transport Forecasting Model, Final Report No. FHWA-HPR-NM-91-07, New Mexico State Highway and Transportation Department, August 1991.

Bureau of Transportation Statistics, 1993 Commodity Flow Survey, State Summaries, U.S. Department of Transportation, Washington, D.C., September 1996.

Cambridge Systematics, Inc., Indiana Statewide Transportation Model, Modal Plan Review Meeting, October 1995.

Cambridge Systematics, Inc., Montana Travel Model Documentation and Forecast Results, November 1994.

Corradino Guoup, Florida Statewide Highway Traffic Forecasting Model, Technical Report 3, Model Operation and Validation Updated to 1990, August 1993.

Caliper Corporation, TransCAD Overview, 1997.

COMSIS Corporation, MINUTP Overview, 1997.

David Evans and Associates, Inc., City of Post Falls, Transportation Study, Final Report, June 1996.

Donohue and Associates, Inc., Cambridge Systematics, Inc. and Congdon Engineering Associates, Inc., Southwest Indiana Highway Feasibility Study, Executive Summary, February 1990.

Dye Management Group, Inc., Montana Statewide Intermodal Transportation Plan, Scope of Work, March 1995.

INRO Consultants Inc., EMME/2 Overview, 1997.

Ismart, Dane and Paul Verchinski, Statewide Requirements in State Transportation Improvement Program, Conference on transportation programming and methods and issues, Transportation Research Circular No. 465, 1996.

JHK & Associates and State of California, Department of Transportation, Travel Forecasting Guidelines, November 1992, <http://www.bts.gov/NTL/DOCS/>.

KJS Associates, Inc., Kolve Engineering and Barton-Aschman Associates, Inc., Michigan Statewide Travel Demand Model Update and Calibration, Phase I Final Report, December 1993.

KJS Associates, Inc., Korve Engineering and Barton-Aschman Associates, Inc., Statewide Travel Demand Model Update and Calibration, Phase I, Revised Working Paper, Task 4: GIS-T Evaluation, for Michigan Department of Transportation, November 1993.

KJS Associates, Inc., Korve Engineering and Barton-Aschman Associates, Inc., Statewide Travel Demand Model Update and Calibration, Phase II, Work Program, for Michigan Department of Transportation, January 1994.

Martin, W. A. and N. A. McGuckin, Travel Estimation Techniques for Urban Planning, Preliminary Draft Final Report, September 1993.

Parsons Brinckerhoff Quade & Douglas, Inc., Consultant Scope of Work for the Oregon Statewide Transportation and Land Use Model Integration Program, Internal Working Paper, May 1996.

Post, Buckley, Schuh and Jernigan, Validation and Update of Florida 1990 Statewide Model, Final Technical Memorandum No. 1, Current Status of Statewide Model, September 1993.

Post, Buckley, Schuh and Jernigan, Validation and Update of Florida 1990 Statewide Model, Final Technical Report, August 1994.

Real Time Traffic Information – Modeling, <http://capacity.ce.gatech.edu/fwyt/class>.

Sarah J. Siwek & Associates, Statewide Transportation Planning Under ISTEA, A New Framework for Decision-making, Prepared for FHWA, U.S.DOT, Washington, D.C., 1996.

Schimpeler Corradino Associates, Florida Statewide Highway Traffic Forecasting Model, Technical Report 2, Collection and Assembly of Data, October 1990.

Schimpeler Corradino Associates, Florida Statewide Highway Traffic Forecasting Model, Technical Report 1, Statewide Model Development, September 1990.

Simkowitz, H.J., Using a Geographic Information System to Build Traffic Analysis Zones From the Census Tiger Files, Presented at the Third National Conference Transportation Planning Methods Applications, April 1991, Dallas, Texas, Transportation Research Board, Washington, DC, 1991.

Sutton, John, GIS Network Editing Tools for Transportation Model Data Management, ESRI GIS User Conference Proceedings, 1997.

Systematica, TRIPS Overview, <http://www.mva-group.com/>.

Sutton, John, Role of Geographic Information Systems in Regional Transportation Planning, Transportation Research Record, No. 1518, Transportation Research Board, National Research Council, 1996.

The Urban Analysis Group, TRANPLAN Overview, 1997.

Thomas, William, Using Geographic Information in Travel Demand Model Network Development, ESRI GIS User Conference Proceedings, 1997.

TMODEL Corporation, TMODEL 2 Overview, 1997.

U.S. Department of Transportation, Bureau of Transportation Statistics, 1993 Commodity Flow Survey State Summaries, September 1996.

Vermont Agency of Transportation, Vermont Statewide Travel Demand Model Development, Phase I Report, December 1993.

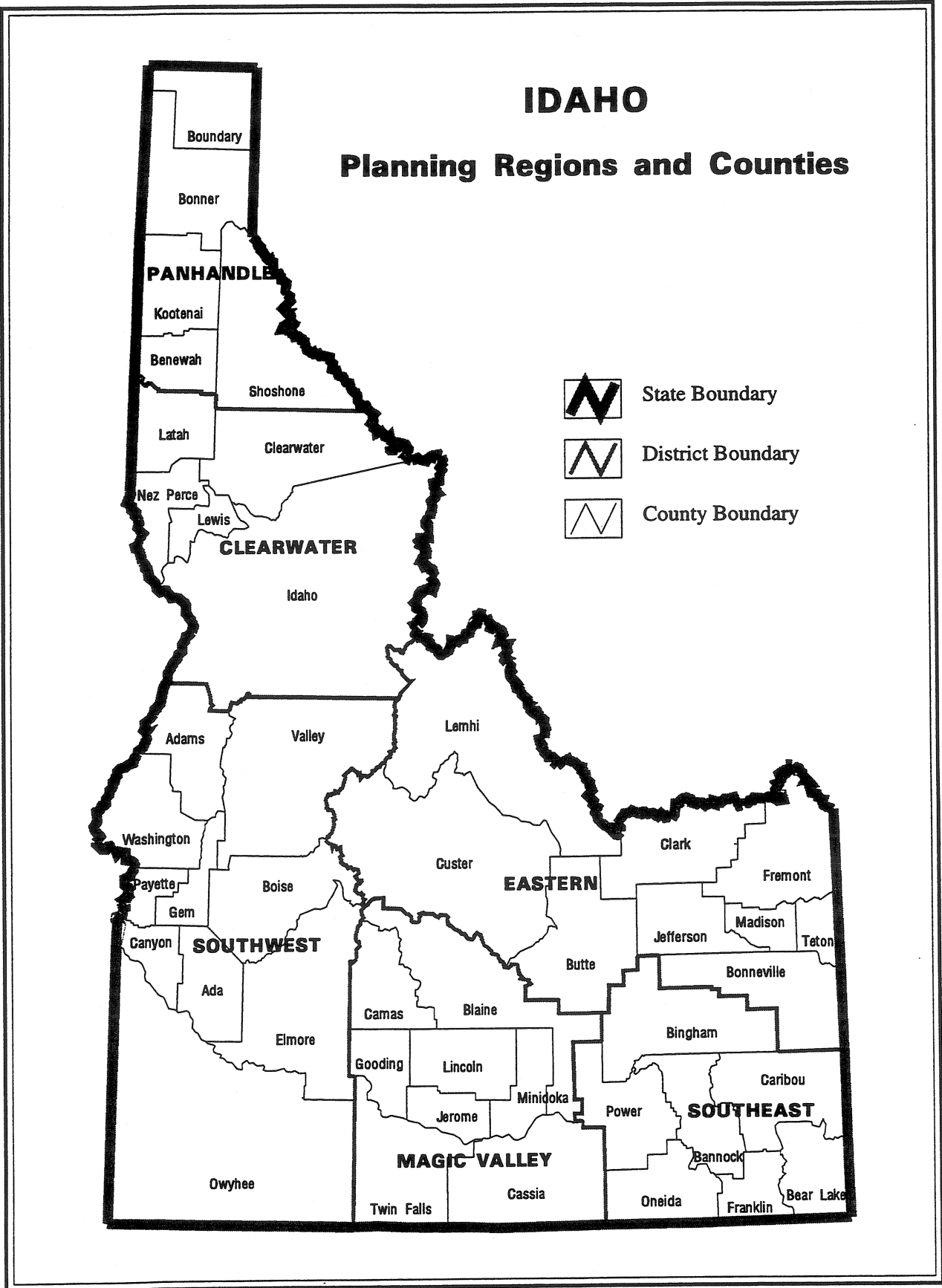
Wilson, Eugene M. and Jiangyan Wang, Wyoming Multimodal Statewide Transportation Planning Model, Phase I Report, University of Wyoming, July 1993.

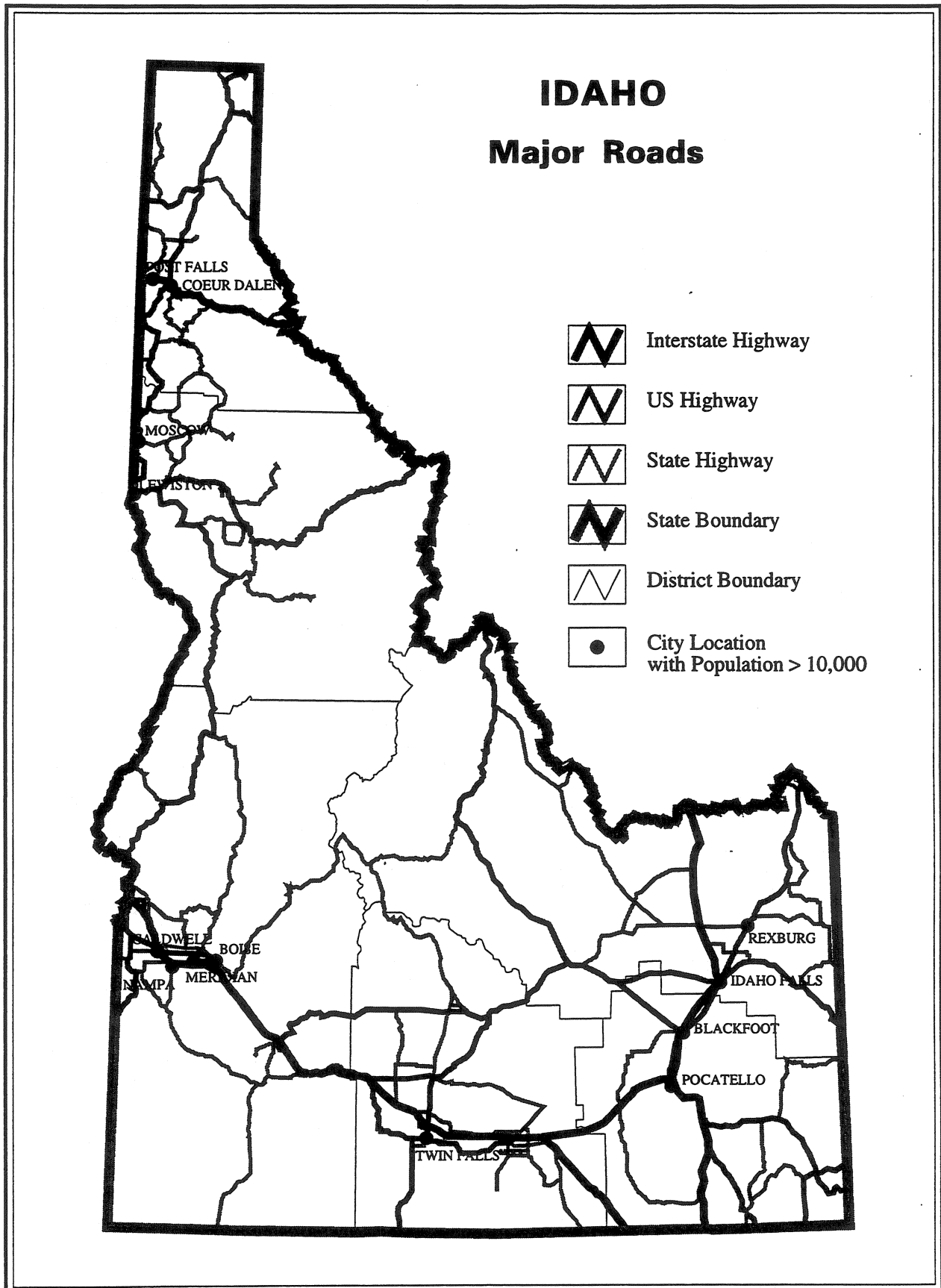
Wilson, Eugene M. and Jiangyan Wang, Statewide Transportation Planning – An Interactive Modeling Process, Final Report, University of Wyoming, May 1995.

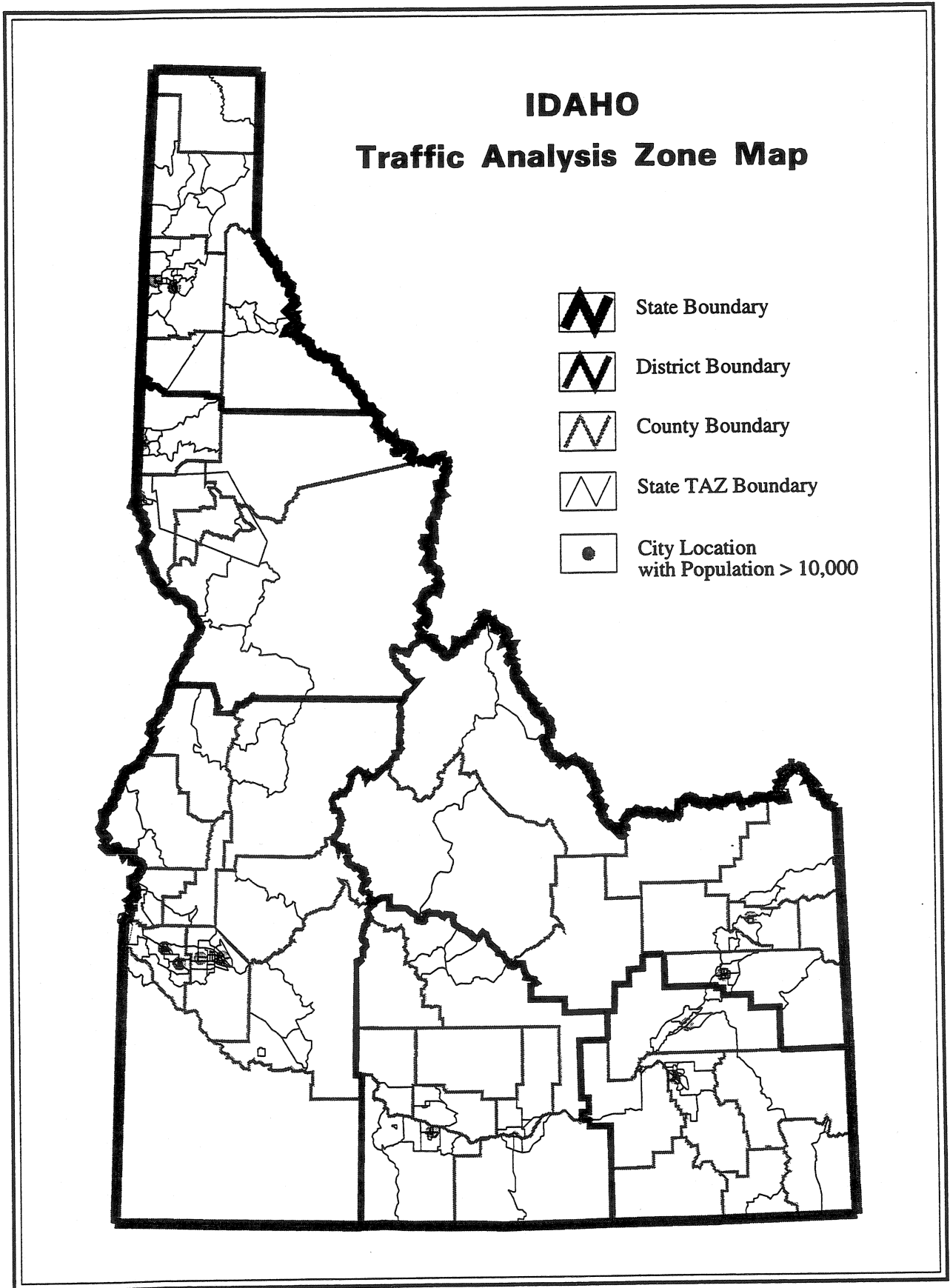
APPENDIX A. Maps

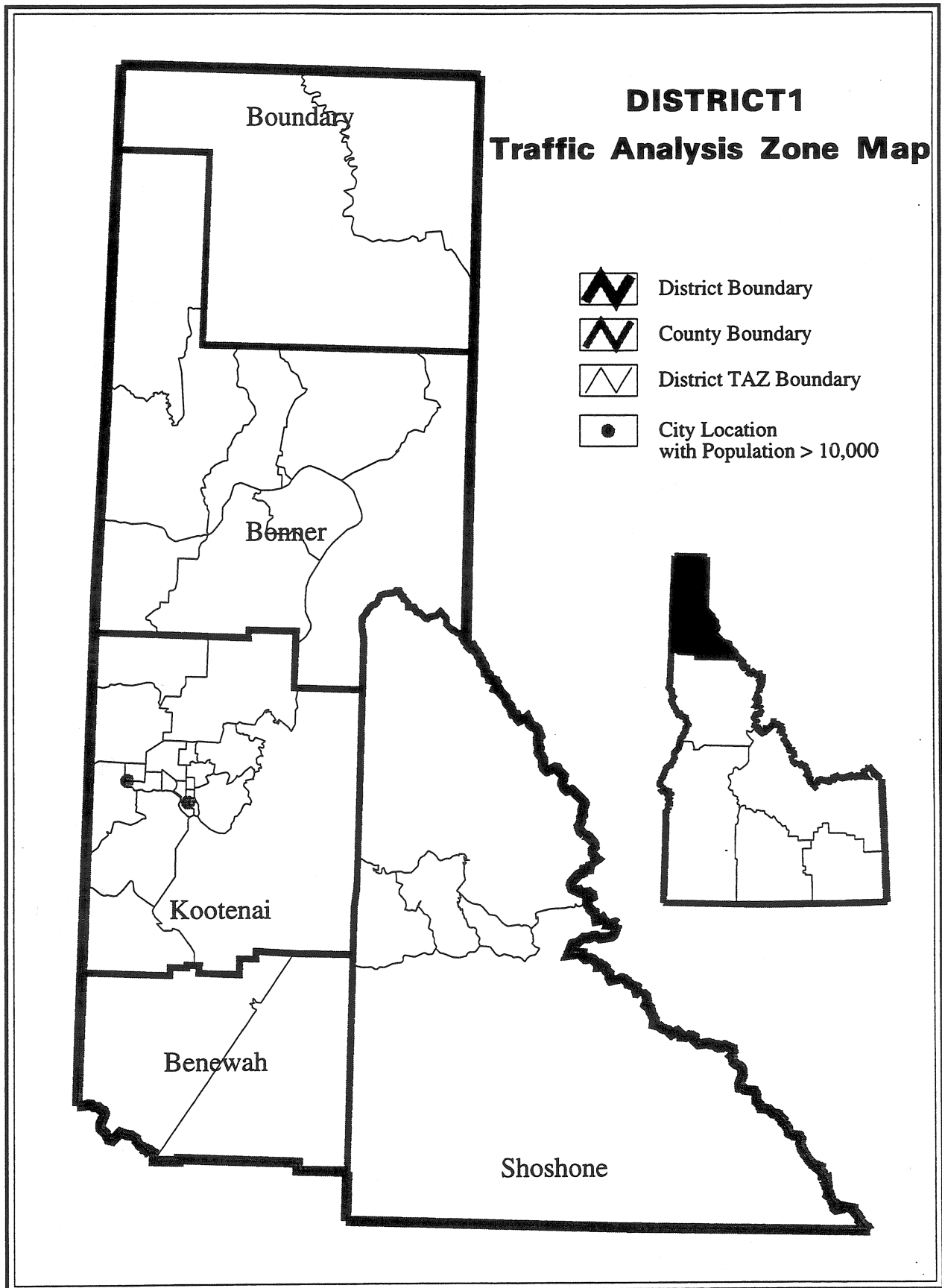
This appendix includes the traffic analysis zone maps and the road maps for Idaho, as a whole and for each district in Idaho.

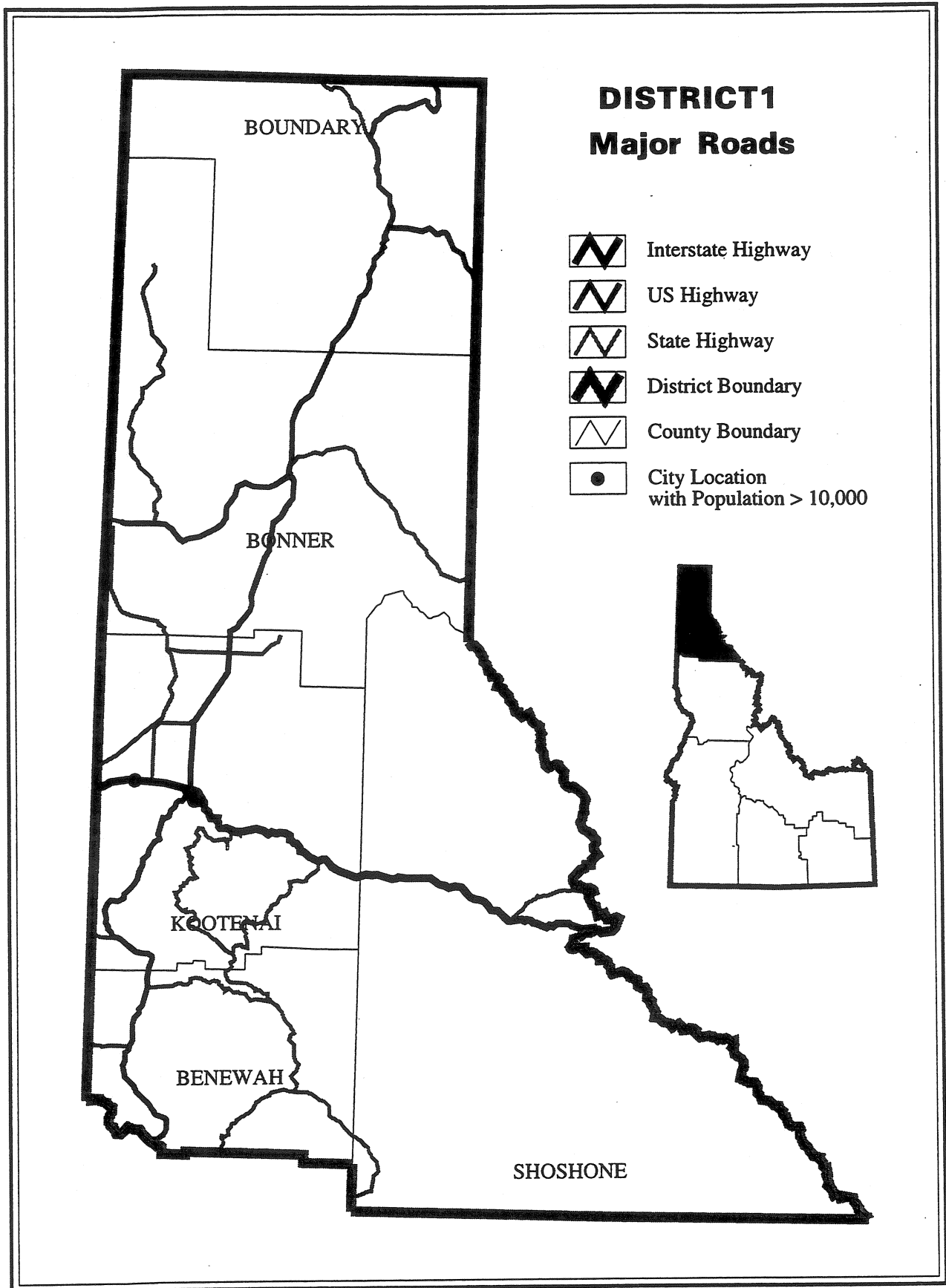
Map 1.-----	Idaho Planning Regions and Counties
Map 2.-----	Idaho Major Roads
Map 3.-----	Idaho Traffic Analysis Zone
Map 4.-----	District 1 - Traffic Analysis Zone
Map 5.-----	District 1 - Major Roads
Map 6.-----	District 2 - Traffic Analysis Zone
Map 7.-----	District 2 - Major Roads
Map 8.-----	District 3 - Traffic Analysis Zone
Map 9.-----	District 3 - Major Roads
Map 10.-----	District 4 - Traffic Analysis Zone
Map 11.-----	District 4 - Major Roads
Map 12.-----	District 5 - Traffic Analysis Zone
Map 13.-----	District 5 - Major Roads
Map 14.-----	District 6 - Traffic Analysis Zone
Map 15.-----	District 6 - Major Roads

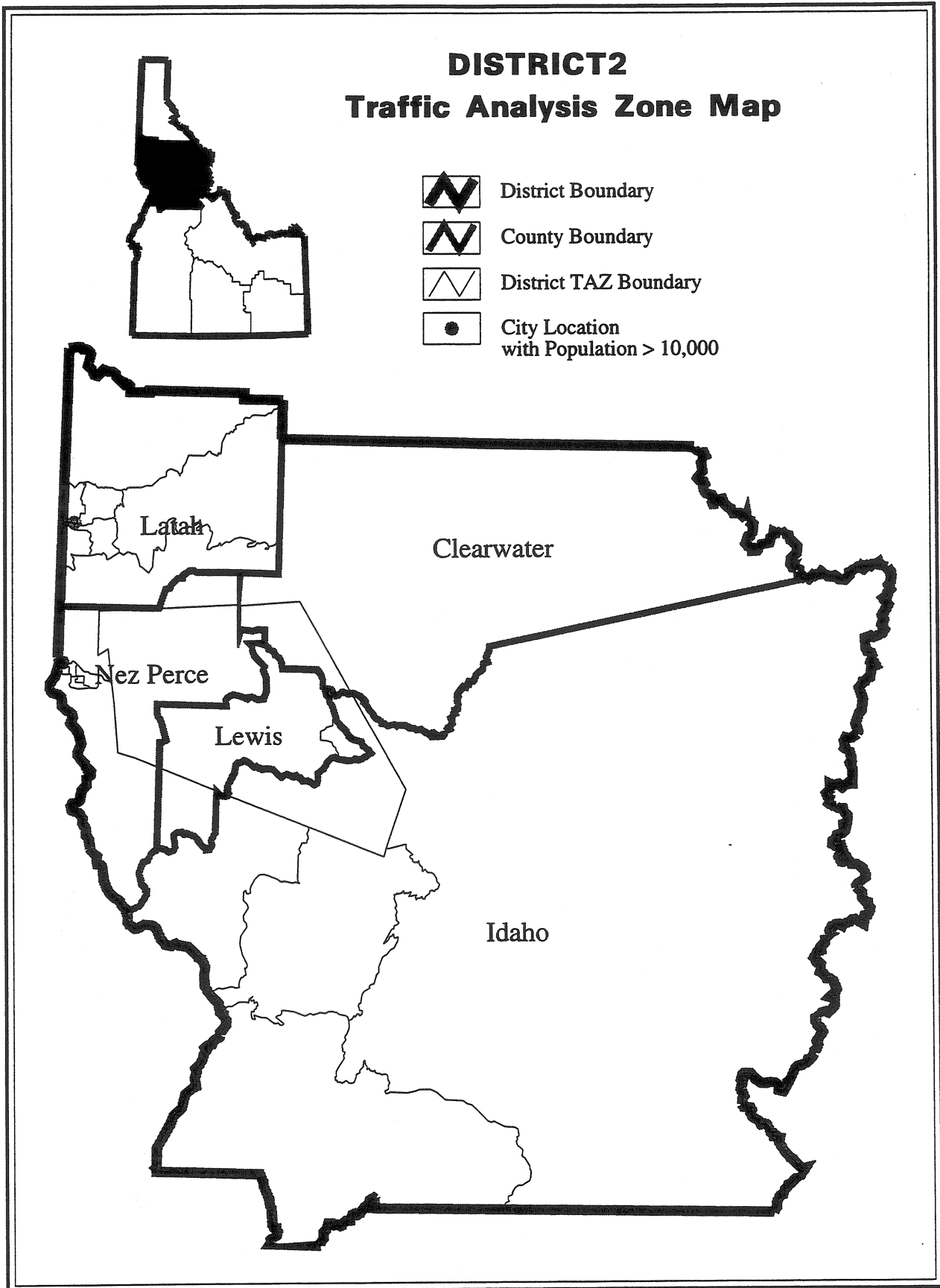


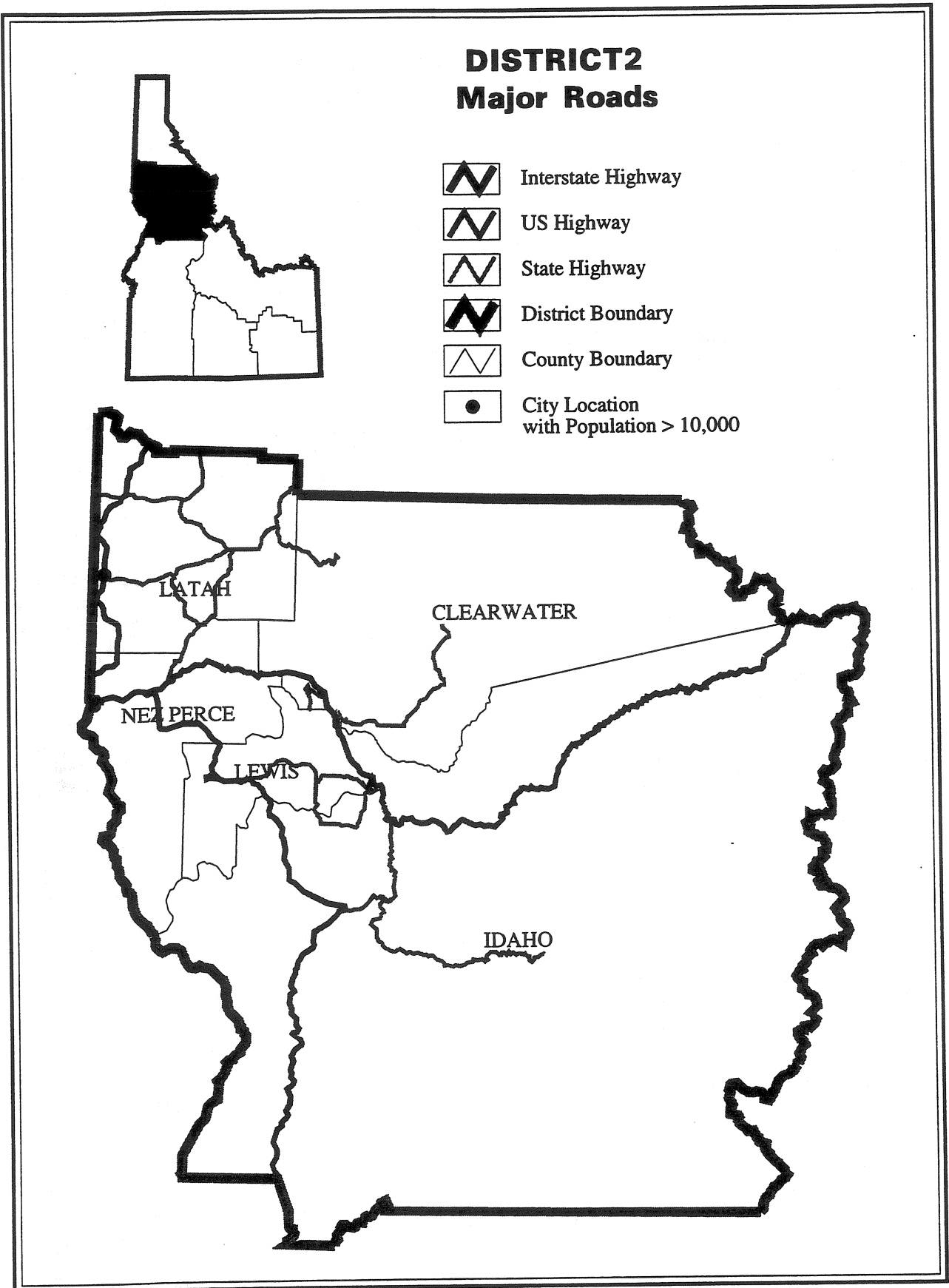


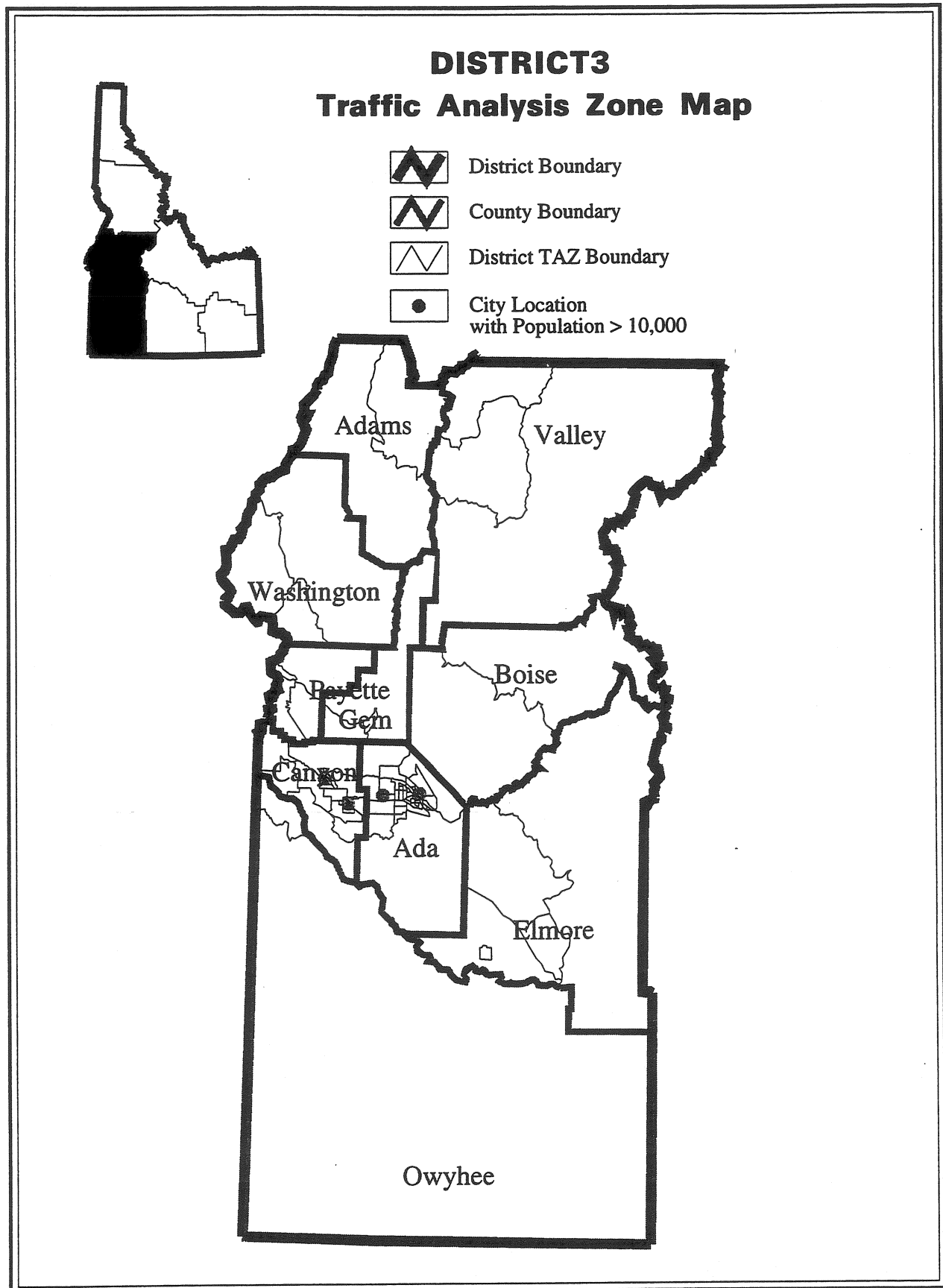


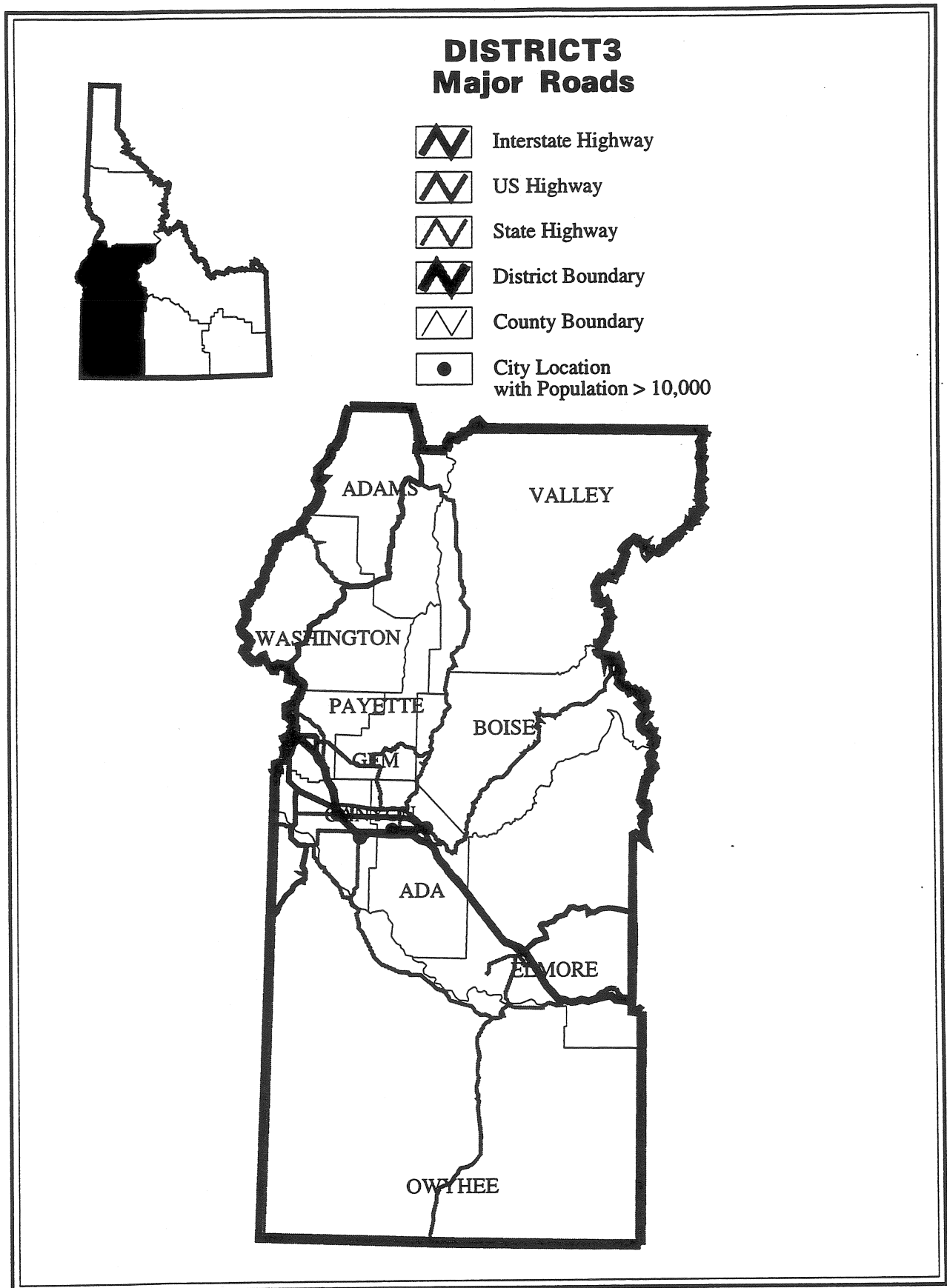










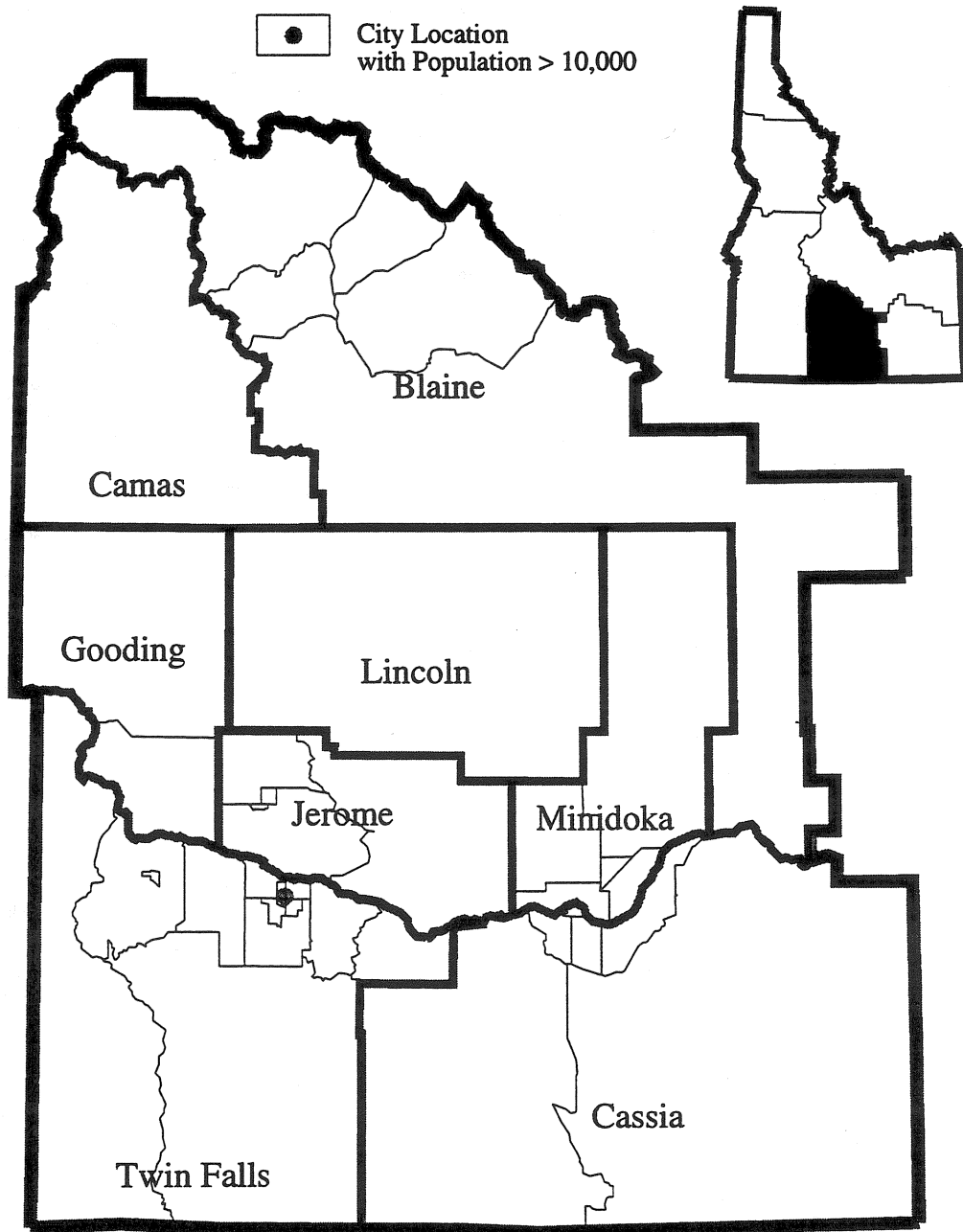












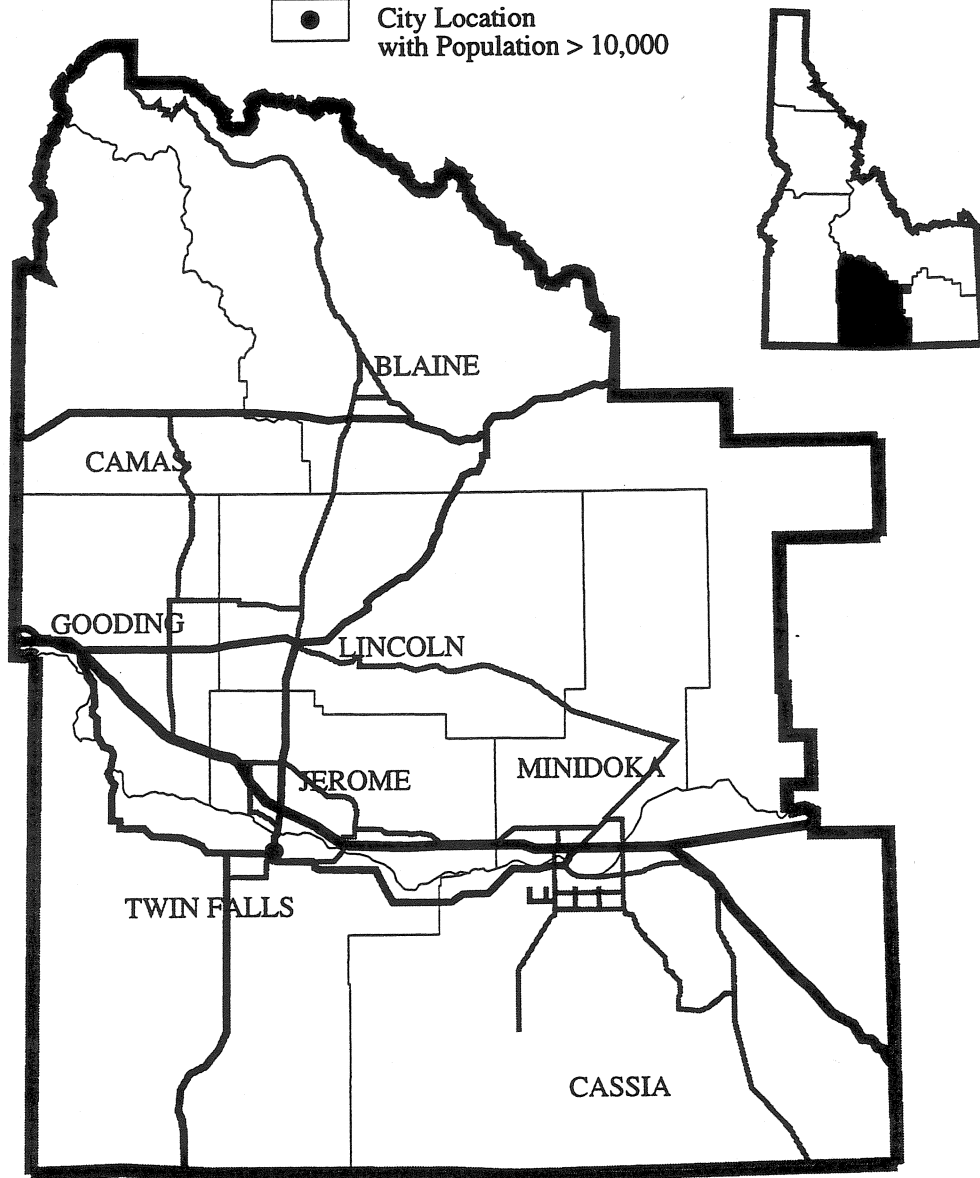
DISTRICT4 Traffic Analysis Zone Map

-  District Boundary
-  County Boundary
-  District TAZ Boundary
-  City Location with Population > 10,000







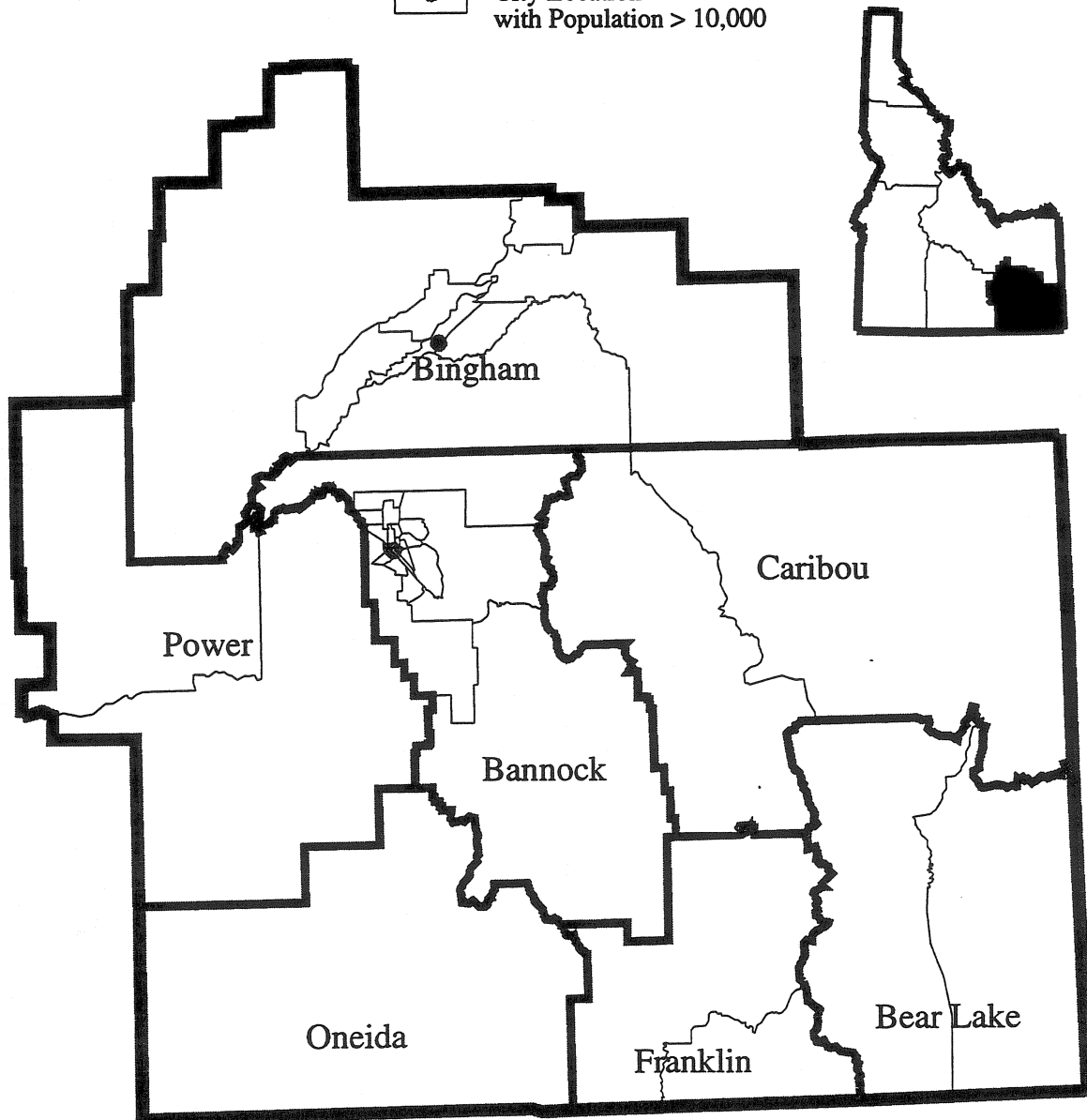
DISTRICT 4 Major Roads

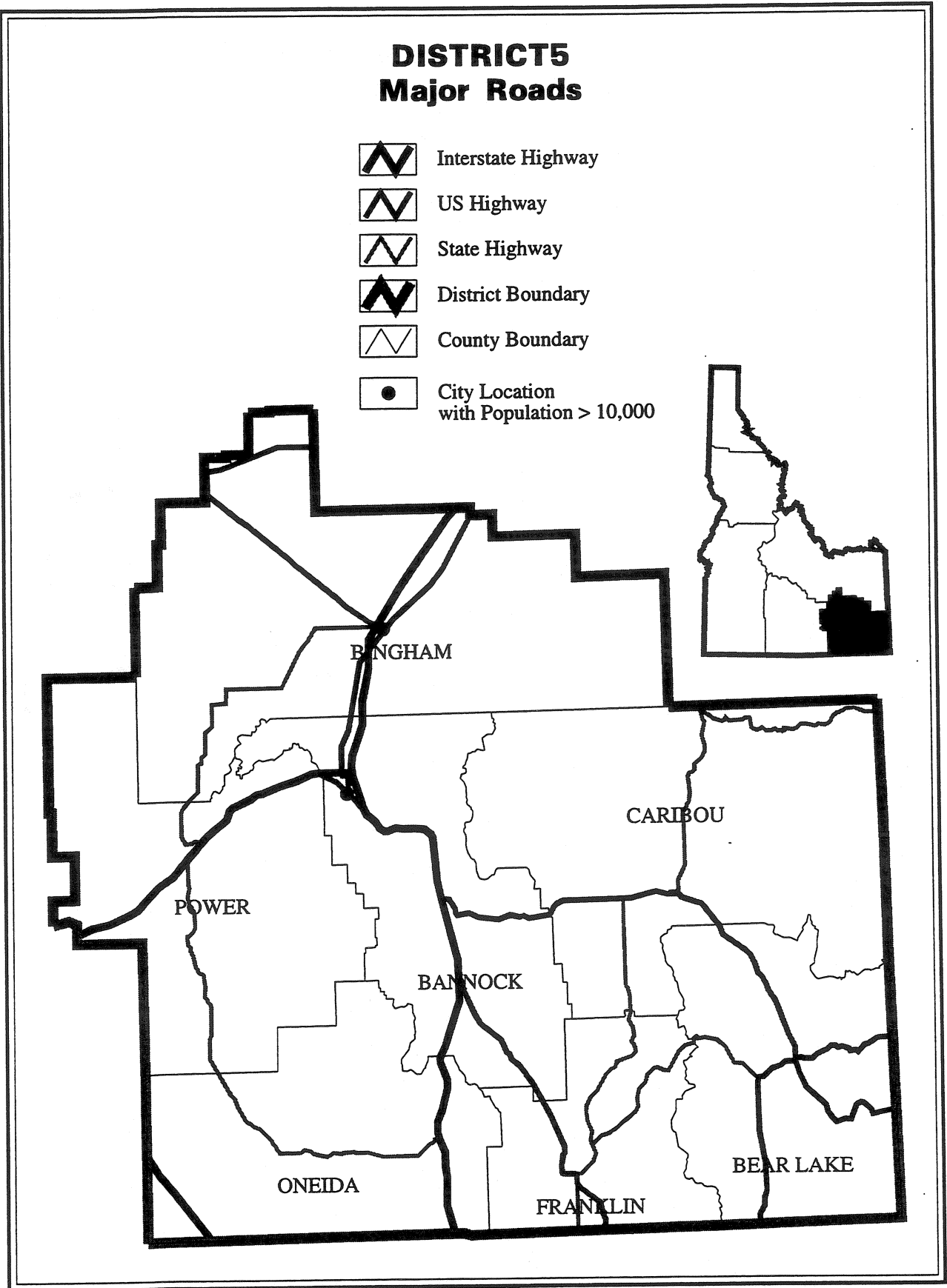
-  Interstate Highway
-  US Highway
-  State Highway
-  District Boundary
-  County Boundary
-  City Location with Population > 10,000







DISTRICT 5 Traffic Analysis Zone Map

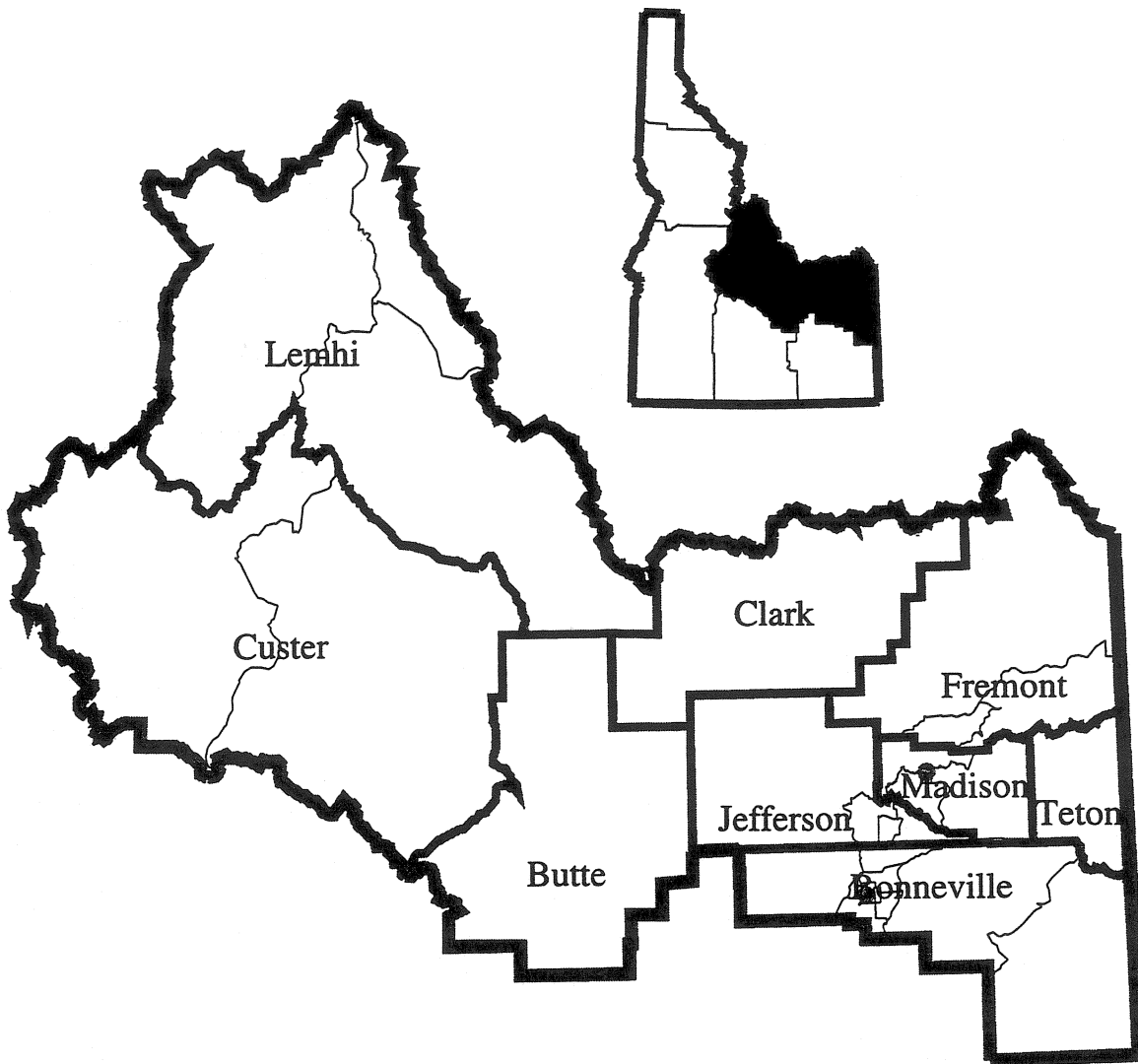
-  District Boundary
-  County Boundary
-  District TAZ Boundary
-  City Location with Population > 10,000











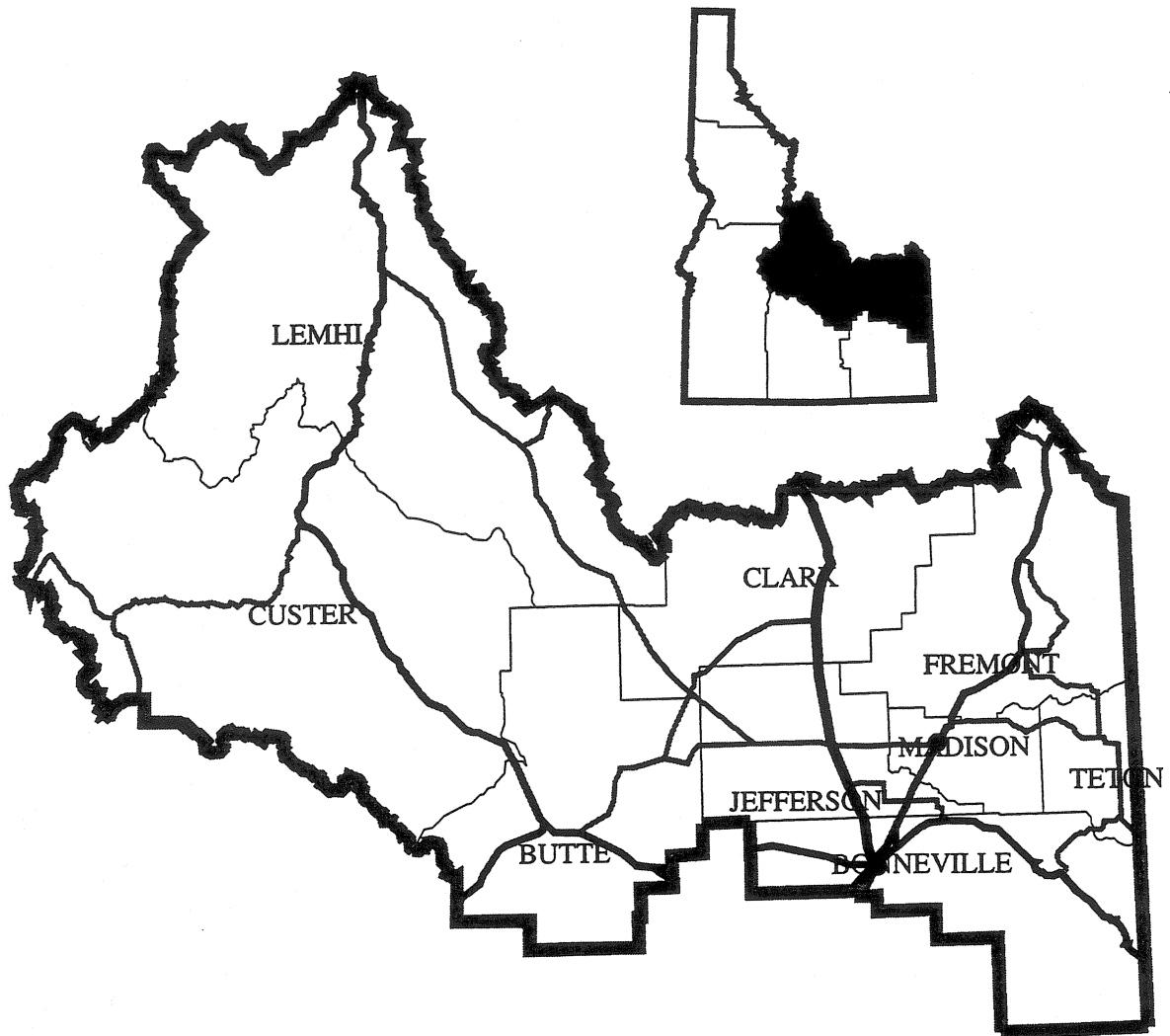
DISTRICT 6 Traffic Analysis Zone Map

-  District Boundary
-  County Boundary
-  District TAZ Boundary
-  City Location
with Population > 10,000



DISTRICT 6 Major Roads

-  Interstate Highway
-  US Highway
-  State Highway
-  District Boundary
-  County Boundary
-  City Location
with Population > 10,000



APPENDIX B. TRANSPORTATION SOFTWARE REVIEW

Parameters		TMODEL2	TransCAD	TranPlan	TRIPS	EMME/2	MINUTP
Hardware and Operation Systems		512 + RAM EGA or VGA	PC or UNIX All windows	PC or UNIX OS/2 or windows	PC and UNIX DOS or windows	PC or UNIX DOS	IBM compatible DOS
Size Limits	Zone	1,000	No limit	9,000	10,000	2,000	2,000
	Links	10,000	No limit	64,000	No limit	40,000	32,700
	Nodes	2,500	No limit	No limit	50,000	16,000	16,300
Travel Demand Analysis							
• Land use: socio-economic data interface, summaries and display		Partially	Fully	Partially	Partially	Partially	Partially
• Travel behavior: household dynamics and trend analysis		Partially	Partially	Partially	Partially	Partially	Partially
• Trip generation: I/O from other processing and programming capabilities		Fully	Fully	Fully	Fully	Fully	Fully
• Trip distribution: functions, options, special generators and calibration feature		Fully	Fully	Fully	Fully	Fully	Fully
• Modal data: commodities, passengers, mode split and calibration features		Partially	Fully	Partially	Partially	Partially	Partially
• Trip assignment: customize algorithms, multi-class and speed/flow flexibility		Fully	Fully	Fully	Fully	Fully	Fully
• Generalized matrix manipulation: functionality and flexibility		Partially	Fully	Partially	Partially	Fully	Partially
• Graphical display of matrix data: OD, select link and impedance		Partially	Fully	Partially	Partially	Fully	Partially
• Survey: disaggregate data handling and logit functions		Partially	Fully	Partially	Partially	Partially	Partially

Network Handling <ul style="list-style-type: none">● On-screen: building, editing an display features● Diagnostics: edit and logical network checking● Node data: intersection impedance and display feature● Plotting: bandwidth, attributes and colors● Integration with GIS and database		Fully Partially Partially Partially Partially	Fully Partially Partially Partially Fully	Fully Fully Partially Partially Partially	Fully Fully Partially Partially Partially	Fully Partially Partially Partially Partially	Fully Partially Partially Partially Partially
Others <ul style="list-style-type: none">● Multi-user: can run on many computers per site installation● Database: easy exchange input/output● EVALS reports: computer delta difference and statistics● Geographic: summaries by area and site specific features● Matrices: manipulation, display, math and flexibility● On-screen & hardcopy plotting: capability and flexibility● Customization: allows for any model flow		Yes Yes Partially Partially Partially Partially Partially	No Yes Partially Fully Fully Fully Fully	Yes Yes Partially Partially Partially Partially Partially	No Yes Partially Partially Partially Partially Fully	Yes Yes Partially Partially Partially Partially Fully	Yes Yes Fully Partially Partially Partially Fully
Cost Annual support fee		Standard copy \$3,800	Standard first copy \$9,995 \$2,500	Standard copy \$8,000 \$1,625	Standard copy \$20,590 %15	Based on sizes \$9,000 – 56,800 %12	Based on sizes \$500 – 7,500 \$500

TransCAD
Caliper Corporation
1172 Beacon Street
Newton, Massachusetts 02161
Tel: (617) 527-4700
Fax: (617) 527-5113

TransCAD is a relatively new travel demand package that integrates GIS capabilities and travel demand analysis. Information on transportation network, freight flows, routes, schedules, transportation analysis zones, passenger demand, and transportation system performance can be stored, displayed, and analyzed at any spatial scale. TransCAD has applications at international, national, regional, and local levels, and can be used for any or all modes of transportation.

TransCAD has five major components:

- The most powerful geographic information system (GIS) available today in the Windows operating system. GIS operations include polygon overlay, buffering, interlayer selection, and aggregation.
- An extend data model, such as networks, paths, tours, nodes, links, flow matrices and dynamic segmentation, that provides essential tools for transportation data display and manipulation.
- The largest collection of transportation analysis procedures ever assembled in one software package. These include:
 - Standard four step UTPS methods
 - Quick response methods
 - Specialized procedures for multimodal models
 - Routing, logistics and optional location models
- Broad and comprehensive sets of transportation, geographic, and demographic data. These include:
 - US DOT National Highway Planning Network
 - US Census TIGER/Line 1994 files
 - Detailed Census demographic and boundary data at all levels
- A powerful development language for creating macros, add-ins, server applications, and custom front-ends.

TransCAD procedures are remarkably fast and can solve mainframe size problems. Procedures include following:

- Trip Generation Procedures - linear, non-linear and logit models.

- Trip Distribution Procedures - Gravity, Fratar, and entropy models.
- Traffic Assignment Procedures - all-or-nothing, incremental, equilibrium, capacity restraint methods.
- Mode Split and Choice Procedures - binary and multinomial logit models.
- Transit Procedures - short path, skim trees.
- Quick Response Procedures - for trip production, attraction and generation.
- Other Related Procedures - OD Matrix estimation, turn penalty editor, Census utilities.
- Statistical Procedures - correlation matrices, one-way and two-way tabulation.
- Routing and Logistics - clustering, regional partitioning, facility location.

Hardware Requirements:

80486 or Pentium - based microcomputer under Windows 3.1, Windows 3.11 (Windows for Workgroups), Windows NT, and Windows 95.

Cost:

Standard TransCAD (First copy)	\$ 9,995
(Copies 2-5)	8,995
(Copies 6 - 15)	7,995
(Copies 16 & up)	6,995
Base TransCAD	2,995
Turnkey TransCAD	19,995
TransCAD Academic Software License	995
TransCAD Lab Pack Software License	2,995

TranPlan

The Urban Analysis Group
50 Oak Court Suite 110
Danville, CA 94526-4048
Phone: 510-838-1363
Fax: 510-838-1372

TranPlan is one of the most commonly used UTP software programs in the U.S. It is a flexible full-functioning travel demand software package that was one of the first to be implemented in DOS based microcomputer. TranPlan may not be the fanciest program, in terms of offering multiple versions of advanced route assignment procedures, but it does provide all of the options normally associated with the traditional four-step UTP process. TranPlan is often favored for areas in which trip estimation and assignment have legal implications or when state planning agencies require standardized model outputs.

Capabilities:

- Trip generation - using user-specified socioeconomic data.
- Trip distribution - Gravity model with extensive statistics and optional K-factors; Fratar model to perform iterative matrix expansion.
- Modal choice - using curvilinear diversions between highway and transit modes.
- Trip assignment - using Equilibrium, all-or-nothing, incremental capacity restraint, iterative capacity restraint and stochastic methods.
- Matrix utilities - update, expand, compress or transpose trip tables; generate zone-to-transit fare matrices; generate trip tables from trip survey data.
- Reporting - detailed reporting and summaries of highway network characteristics, minimum paths and assignment results;

Work is underway on interface modules for the GIS softwares, such as ARC/INFO, MapInfo, AtlasGIS, Maptitude and ArcVIEW.

Size limits:

Zones: 9,000
Links: 64,000
Nodes: 32,000

Hardware requirements:

OS/2 and WINDOWS on PC's, BM RS/6000 AIX (UNIX) , SUN OS (UNIX) systems.

Site License:

TRANPLAN/NIS	\$8,000
TPMENU	\$1,200
ARC/INFO-Arc/View Interface	\$ 600
Academic License	\$ 975

TRIPS

MVA House, Victoria Way, Woking, Surrey GU21 1DD, United Kingdom
Telephone +44 (0)1483 728051
Facsimile +44 (0)1483 755207
email: enquiries@mva.co.uk

TRIPS is a British product, more widely used in Europe than in the USA. TRIPS's primary distinction is its fairly robust dynamic route assignment algorithm, which explicitly considers intertemporal changes in traffic congestion at specific intersections. This makes TRIPS particularly useful for modeling highly congested or saturated flow networks. TRIPS also includes many additional features, which are available at additional cost.

TRIPS is a set of inter-related modules, as below. These contain the 'building blocks' of a model, enabling the user to access the features and facilities to build models which meet individual requirements.

Demand Modeling - Can be used in many innovative ways, also support conventional four-step transportation models.

Trip End Generation and Attraction - Processing three car ownership and six household groups. Using zonal landuse data and user supplied relationships.

Trip Distribution - Calibration, Forecasting and Growth Factoring.

Modal Split - Simple diversion curve functions are used to split trip matrices into modal matrices.

Highway Assignment - Three levels; shortest single path, Burrell or Dial multi-route building algorithms; equilibrium, volume averaging, iterative and incremental assignment techniques; Full intersection modeling; and Dynamic Modeling.

Public Transport Assignment - Three levels; multi-routing algorithm; logit sub-models; Crowd model;

Matrix Estimation - Level 1: accesses commonly available data, such as link counts, trip end; Level 2: allows the use of 'part trip' data; Level 3: provides a hierarchic approach to estimating large matrices.

Matrix Manipulation - Store zone to zone based data; provide tools to build, manipulate, modify, print, 'dump' and analyze matrix contents.
Network Graphics

TRIPSWIN - provides Windows environment.

Graphical Project Management Tool - allow data to be input and checked, model results to be understood, networks to be changed and images created for export to work processors, printer and plotters.

Data Processing - processing of survey data.

Interfacing to TRIPS - Showman Plus traffic count data program; export to databases, spreadsheets or GIS's.

Hardware requirements:

Personal computers using DOS, Windows 3.1, Windows for workgroups or Windows/95.

Sun Unix workstations using Solaris 2.x or SUNOS 4.1.3

HP Unix Workstations using HP-UX.

DEC Unix Workstations using ULtrix.

Key model building parameters are:

Zones - up to 10,000

Nodes - up to 50,000

Links - No limit

Intersections - No limit

Modes (Public Transport) - 20

Lines (Public Transport) - 9999

Cost:

See attached page.

EMME/2

INRO Consultants Inc

Montreal, Canada

Tel: (514) 369-2023

Fax: (514) 369-2026

EMME/2 is a Canadian product that is in many respects the Cadillac of UTP software. It is a flexible, menu-driven travel demand package that is widely used in North America and Europe. Structured in a database format, the software allows for relatively easy and flexible construct of literally any model design and includes state-of-art highway and transit network handling features. Furthermore, this software also allows users many capabilities to analyze results and to graphically display important evaluation measures. EMME/2 does not include default settings for any procedure, reflecting a philosophy that the user should be able to specify an appropriate model form, understand what the model represents, and be aware of its potential limitations. EMME/2, not designed for beginners, is appreciated by more advanced UTP modelers.

Major features:

Matrix manipulation tools - allow implementation of a wide variety of travel demand forecasting models.

Assignment procedures - based on sound theories.

Interactive calculators - allow implementation of evaluation and impact analysis methods.

Powerful macro language - for automating repetitive procedures.

Comprehensive graphic display capabilities - include network scattergrams, matrix histograms, shortest path builders and scenario comparison.

Interactive/graphic network editors - for entering and updating network data.

Capabilities:

- Provides decision support capabilities, allowing the simultaneous description, analysis and comparison of several proposed scenarios, and providing methods for evaluating various transportation and landuse development alternatives.
- Provides a general framework for implementing a wide variety of travel forecasting models. These can range from the simple implementation of a four step model to more refined demand models and their integration into a variety of road and transit assignment procedures. Impact and evaluation analysis is also possible.
- Offers the planner a wide variety of tools for the direct comparison of future scenarios which may reflect changes in the road and transit network or changes in the socio-economic characteristics of the urban area studied.

Hardware requirements:

Intel 486 or Pentium Pcs , SUN SPARC under UNIX, HP 9000 under HP-UX,
IBM RS/6000 under AIX, DEC Alpha under Digital UNIX (OSF/1),
DEC VAX under VMS

Network size limit: 16 sizes

Zones: 250 - 4,000

Nodes: 2,000 - 32,000

Links: 5,000 - 80,000

Turns: 5,000 - 80,000

Transit lines: 250 - 4,000

Transit line segments: 6,250 - 100,000

Cost:

	Class B	Class C	Class D
Size 1 - 16	\$9,000 - \$40,000	\$12,000 - \$48,000	\$14,000 - 56,8000

Interfaces such as the 2.11 Toolbox have been developed allowing GIS Systems like ArcInfo to manage and share modeling data with packages like EMME/2.

MINUTP

COMSIS Corporation
8737 Colesville Road #1100
Silver Spring, MD 20910
301-588-0800
FAX 301-588-5922
comsis@cais.com

MINUTP is another flexible, full-functioning travel demand software package that has a long track record in North America and many users. MINUTP offers state-of-the-art forecasting techniques in a form that is easily applied and understood. It provides these techniques in standard formats and includes extensive flexibility for the user to tailor the application to local conditions.

MINUTP's 4-step Demand Forecasting Process:

Trip Generation: simple rates, cross-classification tables, or regression models.
Processing up to 26 data variables and 9 trip purposes.

Trip Distribution: Gravity model formulation or the Fratar growth-factor technique.

Mode Choice: Logit models, Pivot point methods.

Trip Assignment: Equilibrium, stochastic, iterative, and incremental.

New features:

- The *transit forecasting* capabilities have been expanded to handle larger transit systems, permit interactive graphic editing of transit networks, and provide comprehensive options for defining transit lines and controlling transit path building.
- The *highway assignment* procedures have been upgraded to facilitate analysis of High Occupancy Vehicle lanes by permitting the user to assign HOV and not-HOV trips simultaneously.
- *Matrix utilities* that are extremely powerful and fully capable of applying even the most complex mode choice models are provided.

Size limits of highway network:

Zones: 2,000

Links: 32,700

Nodes: 16,300

Size limits of transit network:

500 transit lines

10 transit nodes

6 transit access node.

Hardware requirements:

IBM compatible machines with 256K RAM and 2 Floppy diskettes.

Cost:

The price of the MINUTP software varies depending upon the size of the application network which is determined by the number of zones and nodes. The following is the price schedule as of August 1990:

Plan	A	B	C	D	E	F	DEM
Zones	50	300	400	500	2000	2000	20
Nodes	200	1200	1600	2000	16380	16380	50
Highway with Graphics	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Transit with Graphics	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Training	No	Opt	Opt	Opt	Opt	Incl	No
Update Cost \$	50	100	100	100	1 Yr.	2 Yrs	
Total Cost \$	500	3000	4000	5000	6000	7500	100

TMODEL 2

TModel Corporation

P.O. Box 1850

Vashon, WA 98070

FAX: (206) 463-5055 or (800) 826-6357

tmodel@tmodel.com or <http://www.tmodel.com>

TMODEL 2 is one of the older PC-based UTP programs. The program treats networks for different modes separately, assigning mode split prior to trip distribution. The program calculates intersection delays with internal variable formulae, rather than having the delay definitions fixed as constants internally by the modeler.

Capabilities:

Trip Generation Capabilities - Six trip purposes and unlimited user-specified land use or standard land use classifications. Pro-/Post-distribution mode split. Full trip tables manipulation features including fratar, transpose, mask, factor, merge, squeeze/expand.

Traffic Assignment Options - Incremental, Iterative, Adjusted Incremental, with capacity restraint or all-or-nothing assignments; select link and select zone; Multi-Point Assignment (MPA), auto external zone calibration, subarea trip table derivation, HOV/SOV assignment, Emissions. Import files from Transplan, Emme/2, QRS, THE, Motors, GIS.

Intersection Analysis - Dynamic node modeling, dynamic turn penalties and prohibitions, pre-load option, graphic representation, frataring of turns, select zone frataring, merging of files, and NCAP capacity analysis package.

Interactive Graphics - Display and edit network information with color, proportional width, text, street names. Land use, trip table, travel time, and modal impedance graphics from variable angles and azimuths. Import TIGER or DXF files for graphic layer display. Desire lines. Trip Length Frequency curves. Level-of-Service using SR209.

Model Limits:

Zones: 1,000

Nodes: 2,500

Links: 10,000

Hardware requirements:

512K + RAM, EGA or VGA monitor, mouse.

Math co-processor recommended.

Plotter support includes HPGL, HPGL/2, PCL5 lasers.

Cost:

TMODEL2 w/NCAP - \$3,800.00

TMODEL2 Educational - \$ 150.00

TMODEL2 Demo - \$125.00

TMODEL2 Upgrade - (Call TModel for price)

Appendix C. Conversion of the ITD highway centerline database to an ARC/INFO coverage and the input data files for TranPlan

The ITD highway centerline database includes two kinds of data useful for statewide transportation planning. The first data file has 50,766 records, listing the coordinates at every 0.1-mile post in Latitude and Longitude. The other is an attribute data file for 1,847 highway segments. The attributes are speed limit (SPDLMT), functional class (FUNC_CLASS), capacity, annual average daily traffic (AADT), and milepost.

The following files were created: an ARC/INFO route coverage, a line coverage, and the TranPlan network data files from the above two files. Compared to the National Transportation Atlas Database 1996, the coverage derived from the ITD database had more details. Some differences between the two, however, were difficult to explain. The following describes the general procedure for converting the ITD data files.

The first step was to reformat the ITD data file into the format required by ARC/INFO using C++ programs we wrote. Table 1 shows the first 12 lines of the coordinate data file used to create an ARC/INFO route coverage. Table 2 shows the attribute data used to produce an event Dbase file.

Table 1. Coordinate data file used to create ARC/INFO route coverage

1010		
0	-116.9398464809	44.0064025257716
0.1	-116.93932695686	44.0050360137471
0.2	-116.93880732929	44.0036694117377
0.3	-116.93828785611	44.0023028930929
0.4	-116.93776840834	44.0009363711388
0.5	-116.93733909048	43.9995565481996
0.6	-116.93681109903	43.9982028404108
0.7	-116.93607983847	43.9968877459167
0.8	-116.93534848705	43.9955726487808
0.9	-116.9346172982	43.9942576324813
1	-116.93388613854	43.9929425204591

Table 2. Attribute data file used to produce event Dbase file

1010,0,5.968,1,65,4147,13000
1010,5.968,12.61,1,65,4021,13000
1010,12.61,17.64,1,65,4021,13000
1010,17.64,24.839,1,65,4021,13000
1010,24.839,25.991,1,65,4147,20000
1010,25.991,26.343,1,65,4147,25949
1010,26.343,26.7,1,65,4147,26000
1010,26.7,27.621,11,65,6533,28771
1010,27.621,27.893,11,65,4251,30000
1010,27.893,28.466,11,65,4251,30000
1010,28.466,32.64,11,65,4251,34590

The completion of an ARC/INFO route coverage and an event table essentially creates a dynamic segmentation data model. Dynamic segmentation allows multiple sets of attributes to be

associated with any portion of a highway network. These attributes can be stored, displayed, queried, and analyzed without affecting the underlying highway network's X Y coordinates. A route coverage has three internal data files in ARC/INFO: an arc attribute table, a route attribute table, and a section table. Tables 3-5 show examples of the three data files. These three files were related through the key items of idroute#, highway#, routeline#, and arclink#.

Table 3. A route coverage's arc attribute table

Record	FNODE#	TNODE#	LPOLY#	RPOLY#	LENGTH	ITDROUTE#	ITDROUTE-ID
1	0	0	0	0	0.874	1	1010
2	0	0	0	0	0.856	2	1010
3	0	0	0	0	0.911	3	1010
4	0	0	0	0	0.927	4	1010
5	0	0	0	0	0.914	5	1010
6	0	0	0	0	0.429	6	1010
7	0	0	0	0	0.181	7	1020
8	0	0	0	0	0.007	8	1021
9	0	0	0	0	0.054	9	1030
10	0	0	0	0	0.005	10	1040
11	0	0	0	0	0.024	11	1050

Table 4. A route coverage's route attribute table

Record	HIGHWAY#	HIGHWAY-ID
1	1	1010
2	2	1020
3	3	1021
4	4	1030
5	5	1040
6	6	1050
7	7	1260
8	8	1270
9	9	1270
10	10	1330
11	11	1340

Table 5. A route coverage's section table

ROUTELINK#	=	1
ARCLINK#	=	1
F-MEAS	=	0.000
T-MEAS	=	0.100
F-POS	=	0.000
T-POS	=	0.167
HIGHWAY#	=	1
HIGHWAY-ID	=	1
2		
ROUTELINK#	=	1
ARCLINK#	=	1
F-MEAS	=	0.100
T-MEAS	=	0.200
F-POS	=	0.167
T-POS	=	0.335
HIGHWAY#	=	2
HIGHWAY-ID	=	2

An event table such as the example in Table 6 may be maintained separately from the above route coverage in ARC/INFO or any other database management system. An event table can therefore

be updated without affecting the route coverage. On the other hand, the event data can be displayed and queried by relating the event table to the route coverage.

Table 6. An event table

1			
HIGHWAY-ID	=		1010
BEGINNING_MP	=		0.000
ENDING_MP	=		5.968
FUNC_CLASS	=	1	
SPDLMT	=	65	
CAPACITY	=		4147
AADT	=		13000
2			
HIGHWAY-ID	=		1010
BEGINNING_MP	=		5.968
ENDING_MP	=		12.610
FUNC_CLASS	=	1	
SPDLMT	=	65	
CAPACITY	=		4021
AADT	=		13000

An event coverage is produced from a route coverage and an event table, i.e., by associating segment attributes with the graphic file. Table 7 shows an arc attribute table and Table 8, a node attribute table from the event coverage created. These two tables were later prepared to produce the input data files for TranPlan.

Table 7. An event coverage's arc attribute table

1			
FNODE#	=	3	
TNODE#	=	1	
LPOLY#	=	0	
RPOLY#	=	0	
LENGTH	=	7043.440	
EVENTCOVPCC#	=	1	
EVENTCOVPCC-ID	=	4203	
HIGHWAY-ID	=		1580
BEGINNING_MP	=		6.325
ENDING_MP	=		11.185
FUNC_CLASS	=	6	
SPDLMT	=	55	
CAPACITY	=		2018
AADT	=		654
2			
FNODE#	=	4	
TNODE#	=	2	
LPOLY#	=	0	
RPOLY#	=	0	
LENGTH	=	5701.169	
EVENTCOVPCC#	=	2	
EVENTCOVPCC-ID	=	4185	
HIGHWAY-ID	=		1540
BEGINNING_MP	=		534.720
ENDING_MP	=		538.560
FUNC_CLASS	=	2	
SPDLMT	=	55	
CAPACITY	=		1634
AADT	=		1297

Table 8. An event coverage's node attribute table

Record	ARC#	EVENTCOVPCC#	EVENTCOVPCC-ID	XCOORD*	YCOORD*
1	1	1	1	*****	*****
2	2	2	2	*****	*****
3	1	3	3	*****	*****
4	2	4	4	*****	*****
5	3	5	5	*****	*****
6	4	6	6	*****	*****
7	6	7	7	*****	*****
8	7	8	8	*****	*****
9	8	9	9	*****	*****
10	9	10	10	*****	*****
11	10	11	11	*****	*****

*The X Y coordinates cannot be shown but are available.

One manipulation required by TranPlan is to add dummy links from the centroids of internal and external traffic analysis zones to the highway network in event coverage. This can be done in ARC/INFO in three steps: create point coverage with the centroids, use the NEAR command to find the nearest nodes in the network to the centroids, and add dummy links by connecting the centroids to their nearest nodes.

After the event coverage was prepared, the coordinates of the start and end points of each arc and attribute data as the ASCII files were downloaded (Tables 9 and 10).

Table 9. An ASCII file unloaded from an event coverage's arc attribute table

FNODE	TNODE	LENGTH	SPDLIMIT	CAPACITY
3	1	7043.440	55	2018
4	2	5701.169	55	1634
5	4	11541.871	55	2018
6	5	5135.527	55	1599
6	3	7575.537	55	2018
7	6	2106.501	55	1599
8	7	6049.569	55	1975
9	8	5590.046	55	2018
10	9	5466.343	55	2018
10	11	3687.956	55	2571
11	12	6196.793	55	2105

Table 10. An ASCII file unloaded from an event coverage's node attribute table

NODE ID	X-COOR	Y-COOR
1	-30326.148	817846.750
2	-7052.831	817227.188
3	-24969.965	814499.688
4	-7034.805	811602.250
5	-17429.434	810861.313
6	-21548.414	807794.125
7	-20437.494	806004.375
8	-18979.611	800278.875
9	-17451.521	795088.813
10	-15767.140	789929.938
11	-12917.243	787589.188

Appendix D. Example of Statewide Traffic Demand Modeling Using TranPlan

TranPlan follows the standard four-step process in traffic demand modeling. It is a PC-based software package, and the user can execute the package through a menu-driven interface or a batch file. TranPlan is not particularly user friendly. This is why it was decided to run TranPlan with preliminary data collected, a task that was not specified in our proposal. The following explains the execution of TranPlan in sequential steps.

Step 1 - Generate a statewide highway network

The TranPlan function, BUILD HIGHWAY NETWORK, allows the user to either generate a new highway network or update an existing network. The function requires two input files: *node.txt*, with the X, Y coordinates of each node; and *link.txt*, with the attributes of each link such as speed limits, capacity, and ground traffic counts. The output file can be displayed and queried in the HNIS (Highway Network Editor) module. The two input files were prepared from the ITD highway centerline database (Appendix C). The output was called *highnet.dat*, which consisted of the highway network description, and nodes, links, and attributes in TRANPLAN format.

Step 2 - Skim the minimum impedance paths to produce interzonal impedance matrix

The TranPlan function, HIGHWAY SELECTED SUMMATION, can skim the minimum impedance paths, either totally or selectively, to produce interzonal impedance matrices. The *highnet.dat* from Step 1 was used as the input, and the output was called *hwyskim.tem*, which contained one merged skim table based on the time factor. Table 1 shows the skim table for zone 1.

Step 3 - Calculate the intrazonal impedance

The TranPlan function, BUILD INTRAZONAL IMPEDANCE, allows the user to generate the intrazonal impedance values for any skim table based on the nearest zones. TranPlan calculates the intrazonal impedance as one-half the average impedance to the adjacent zones. *hwyskim.tem* from Step 2 was used as the input and called *hwycalc.skm* as the output file (Table 2).

Step 4 - Replace interzonal and intrazonal impedance of external stations as 0

The MATRIX UPDATE function was used to replace the interzonal and intrazonal impedance values of external stations as 0. The input file was *hwycalc.skm* from Step 3 and the output file was named *hwyskim.dat*. Table 3 shows the skim table for zone 1 and external station 45. Notice that the interzonal and intrazonal impedance values of external station 45 are set at 0.

Step 5 - Distribute trips

The Gravity Model is the most widely used technique for trip distributions. To draw an analogy to Newton's Law of Gravity, trip productions and attractions equate the masses and the travel time factor function equates the inverse distance function. The GRAVITY MODEL function in TranPlan requires the input of trip productions and attractions stratified by class of trip purposes, travel impedance factors, and zone-to-zone travel indices. The function checks the acceptability of computed attractions, and if necessary, adjusts the calculated attractions to each zone to equal the

input attractions. The following files: *hwyskim.dat* from Step 4, a trip end production and attraction file *tr97.txt*, and a friction factor file *ndff.prn* as were used as the input data. Tables 4 and 5 show parts of *tr97.txt* and *ndff.prn*. Appendix E provides a detailed account of the procedure for deriving *tr97.txt*.

The output from the GRAVITY MODEL function was called *hwygra.dat*, which included tables of zone-to-zone distributed trips for each trip purpose. Table 6 shows trip tables between zone 1 and zone 45 for trip purpose 1.

Step 6 - Balance trip tables

The MATRIX TRANSPOSE function was used to generate an origin-destination matrix from the production-attraction matrix, *hwygra.dat*. The output named *totltabl.dat* was the sum of *hwygra.dat* and its transposed matrix, divided by 2. Table 7 shows a portion of *totltabl.dat*.

Step 7 - Convert person trips to vehicle trips

The MATRIX UPDATE function was used to convert person trips into vehicle trips. The input was *totltabl.dat* from Step 6. Table 8 shows part of the output named *hwyveh.dat*.

Table 1. Interzonal impedance table for zone 1

ORIGIN ZONE		1 SKIM VALUE TIME 1										
TO ZONE		-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0-	
1	0.00											
11	418.16	90.11	172.87	160.07	183.21	218.54	355.95	260.72	296.94	788.99		
21	611.10	472.07	704.24	463.91	860.62	821.09	512.60	624.82	736.78	510.91		
31	773.79	797.90	864.15	679.13	826.28	535.81	656.69	557.10	663.12	848.70		
41	855.32	641.41	693.66	661.49	736.16	806.88	774.69	682.97	652.63	713.13		
51	136.18	826.21	842.05	386.11	40.95	46.11	149.92	48.46	106.90	131.11		
61	899.12	179.15	176.70	204.69	410.38	251.35	480.23	827.90	850.71	830.35		
71	871.55	896.42	519.82	546.77	574.36	671.20	702.57	740.87	817.86	832.58		
		862.05	859.73	865.15	907.17	871.29						

Table 2. Intrazonal and Interzonal Impedance Table for Internal Zone 1 and External Zone 45

ORIGIN ZONE		1 SKIM VALUE TIME 1										
TO ZONE		-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0-	
1	21.77											
11	418.16	90.11	172.87	160.07	183.21	218.54	355.95	260.72	296.94	788.99		
21	611.10	472.07	704.24	463.91	860.62	821.09	512.60	624.82	736.78	510.91		
31	773.79	797.90	864.15	679.13	826.28	535.81	656.69	557.10	663.12	848.70		
41	855.32	641.41	693.66	661.49	736.16	806.88	774.69	682.97	652.63	713.13		
51	136.18	826.21	842.05	386.11	40.95	46.11	149.92	48.46	106.90	131.11		
61	899.12	179.15	176.70	204.69	410.38	251.35	480.23	827.90	850.71	830.35		
71	871.55	896.42	519.82	546.77	574.36	671.20	702.57	740.87	817.86	832.58		
		862.05	859.73	865.15	907.17	871.29						

ORIGIN ZONE		45 SKIM VALUE TIME 1										
TO ZONE		-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0-	
1	40.95											
11	412.59	84.54	167.30	154.50	177.64	212.97	350.38	255.15	291.37	783.42		
21	605.53	466.50	698.67	458.34	855.05	815.52	507.03	619.25	731.21	505.34		
31	768.22	792.33	858.58	673.56	820.71	530.24	651.12	551.53	657.55	843.13		
41	849.75	635.84	688.09	655.92	730.59	801.31	769.12	677.40	647.06	707.56		
51	130.61	820.64	836.48	380.54	17.60	29.44	144.35	42.89	101.33	125.54		
61	893.55	173.58	171.13	199.12	404.81	245.78	474.66	822.33	845.14	824.78		
71	865.98	890.85	514.25	541.20	568.79	665.63	697.00	735.30	812.29	827.01		
		856.48	854.16	859.58	901.60	865.72						

Table 3. Skim Table for Zone 1 and Zone 45 after Update

ORIGIN ZONE		1 SKIM VALUE TIME 1									
TO ZONE		-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0-
1	1	21.77	90.11	172.87	160.07	183.21	218.54	355.95	260.72	296.94	788.99
11	11	418.16	472.07	704.24	463.91	860.62	821.09	512.60	624.82	736.78	510.91
21	21	611.10	797.90	864.15	679.13	826.28	535.81	656.69	557.10	663.12	848.70
31	31	773.79	641.41	693.66	661.49	736.16	806.88	774.69	682.97	652.63	713.13
41	41	855.32	826.21	842.05	386.11	40.95	46.11	149.92	48.46	106.90	131.11
51	51	136.18	179.15	176.70	204.69	410.38	251.35	480.23	827.90	850.71	830.35
61	61	899.12	896.42	519.82	546.77	574.36	671.20	702.57	740.87	817.86	832.58
71	71	871.55	862.05	859.73	865.15	907.17	871.29				

ORIGIN ZONE		45 SKIM VALUE TIME 1									
TO ZONE		-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0-
1	1	40.95	84.54	167.30	154.50	177.64	212.97	350.38	255.15	291.37	783.42
11	11	412.59	466.50	698.67	458.34	855.05	815.52	507.03	619.25	731.21	505.34
21	21	605.53	792.33	858.58	673.56	820.71	530.24	651.12	551.53	657.55	843.13
31	31	768.22	635.84	688.09	655.92	730.59	801.31	769.12	677.40	647.06	707.56
41	41	849.75	820.64	836.48	380.54	0.00	0.00	0.00	0.00	0.00	0.00
51	51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
61	61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
71	71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 4. The First 10 Records of tr97.txt file

GP	1	1	209651	130286	69478	331681	215145				
GP	2	1	3400	2112	1195	5436	2751				
GP	3	1	64492	39656	21951	102376	60231				
GP	4	1	5748	3457	2218	9318	4460				
GP	5	1	8155	5037	2878	13071	6561				
GP	6	1	34278	20506	12590	54147	31188				
GP	7	1	14708	9213	4951	23563	15880				
GP	8	1	3800	2330	1400	6103	3076				
GP	9	1	27863	17366	9687	44675	22348				
GP	10	1	68770	41933	22667	107033	65978				

Table 5. The First 10 Records in file ndff.prn

GF	1	1	0	0	0	0	0
GF	2	1	13000	1500	600	180	123
GF	3	1	12390	2000	700	250	138
GF	4	1	10720	3200	750	400	156
GF	5	1	8500	4200	800	650	178
GF	6	1	7000	6000	850	1000	204
GF	7	1	4500	10000	1000	1500	237
GF	8	1	2300	11000	1200	2300	278
GF	9	1	1730	12000	1500	3000	331
GF	10	1	1520	13000	1900	4000	400

Table 6. Trip Tables for Zone 1 and Zone 45 in Purpose 1

[illegible]

Table 7. Trip table for zone 1 purpose 1

ORIGIN	ZONE	PURPOSE	TOTAL ORIG/PROD
	TO ZONE	-1-	-8- -9- -0-
	1	207598	0 0 0
	41	0	133 516 828
	51	2488	0 0 0

Table 8. Vehicle trip table for zone 1 purpose 1

[illegible]

Step 8 - Combine all purpose trip tables into final total trip table

The MATRIX MANIPULATE function was used to combine five trip tables, each for a different trip purpose, into one total trip table. The input was *hwyveh.dat* from Step 7. Table 9 shows a portion of the output named *finaltt.dat*.

Step 9 - Assign vehicle trips to the network

The TranPlan function, LOAD HIGHWAY NETWORK, assigns vehicle trips to the network. The default method of assignment is all-or-nothing. Using this methodology, all selected intrazonal highway trips are loaded on the minimum paths (based on travel time) of the input highway network. The *highnet.dat* and *finaltt.dat* are used as the input. The output named *loadnet.dat* was the same as the input highway network file, but with the addition of assigned link volume and adjusted impedance data.

The loaded highway network can be displayed and queried using the Highway Network Editor (HNIS) in TranPlan. The functions of REPORT HIGHWAY NETWORK and REPORT HIGHWAY LOAD create detailed text reports about the highway network. Table 10 shows a portion of the report.

TranPlan has a utility program called NETCARD, which can be used to convert a highway network or loaded highway network file from the TranPlan internal format to the "card-image" (Table 11). The card-image has the same format as that of the initial input files, *node.txt* and *link.txt*. Therefore, the output from TranPlan can be processed and converted to an ARC/INFO coverage after being reformatted.

Table 9. Final Total Trip Table for Zone 1

ORIGIN ZONE	PURPOSE 1	657253 TOTAL ORIG/PROD
TO ZONE	-1-	-8- -9- -0-
1	645443	0 0 0
41	0	1453 422 1446
51	6440	0 0 0

Table 10. A report of the loaded highway network

[illegible]

Table 11. A card-image of the loaded highway network

N	1	-37386	797479				
N	2	-31243	725659				
N	3	15200	652406				
N	4	-44924	656936				
N	5	-52523	622047				
N	6	-52163	582871				
N	7	36487	545745				
N	8	-66842	529808				
N	9	-31003	509774				
N	10	147598	383110				
.							
.							
76	9180	175S3000	0 1 0 0 0	0	31981		
80	450	109S3000	0 1 0 0 0	0	7681		
80	820	440S5500	0 1 0 0 0	654	7691		
81	460	103S3000	0 1 0 0 0	0	15021		
81	830	356S5505	0 1 0 0 0	1297	15021		
82	800	440S5500	0 1 0 0 0	654	7681		
82	850	473S5500	0 1 0 0 0	823	7691		
83	810	356S5505	0 1 0 0 0	1297	15021		
83	840	721S5497	0 1 0 0 0	1231	15021		
84	830	721S5497	0 1 0 0 0	1231	15021		
84	850	320S5501	0 1 0 0 0	1519	15021		
85	820	473S5500	0 1 0 0 0	823	7681		
85	840	320S5501	0 1 0 0 0	1519	15021		
85	860	131S5497	0 1 0 0 0	1519	22711		
.							
.							

Appendix E. Procedure for Trip Generation

In the example, each county in Idaho was chosen as a separate traffic analysis zone (TAZ). First, five trip purposes were defined: home-based work (HBW), home-based shopping (HBSH), home-based school (HBSC), home-based other (HBO), and nonhome-based (NHB). However, no detailed data about truck trips were available for this preliminary model.

The next step was to develop the trip generation method by trip purpose. The two most common methods are cross-classification and multiple regression. The cross-classification approach to trip generation usually stratifies households by size (number of members) and some measure of mobility such as autos available for use by household members. The regression technique is typically based on household survey data, and relates work trips produced by households to one or more independent variables such as member of households, population, autos available, and income.

In this study, the cross-classification method was selected for establishing trip production rates for HBW, HBSH, HBSC, and HBO. For NHB trip productions, the linear regression technique was used that equates travel to employment and household characteristics. The linear regression technique was also used to estimate trip attractions for all purposes.

The trip rates and the linear regression equations were borrowed from the Vermont statewide transportation model. The Vermont study used a household survey to derive the relationships between household characteristics and travel by members of the household. These person-trip relationships were then categorized by trip purpose over a 24-hour period.

Internal zonal trip productions and attractions

1. Home-based productions

The following statistics were downloaded from the 1990 Census CD-ROM by county: total employment, retail employment, school employment, household, household with vehicle 0, 1, 2, 3+, and household with person 1, 2, 3, 4, 5, 6, 7+ . Because the trip rates from the Vermont study were only available for the household with person 1, 2, 3, 4+, the number of households with person 4, 5, 6, 7+ were added together to make a category 4+. Table II.1 shows the household data for Ada county.

Table II.1 Household data by size and autos for Ada County

Person/HH	Autos / HH				
	0	1	2	3+	
1					18218
2					26682
3					12972
4+					19630
	3060	22739	33514	18158	

To use the cross-classification method, the cell values in Table II.1 had to be estimated to produce a matrix. The estimation equation was as follows:

$$\text{Cell}_{ij} = (\text{sum of } i \times \text{sum of } j) / \text{total}$$

where, total is the average of the row sums and column sums

Table II.2 shows the completed household matrix for Ada County. Table II.3 shows the trip rate matrix borrowed from the Vermont study.

Table II.2. The household matrix for Ada County

<u>Persons/HH</u>	<u>Autos/HH</u>			
	0	1	2	3+
1	719	1053	512	775
2	5346	7830	3806	5760
3	7879	11540	5610	8490
4+	4269	6252	3039	4600

Table II.3. The trip rate matrix based on household data

<u>Persons/HH</u>	<u>Autos/HH</u>			
	0	1	2	3+
1	0.8	1.0	1.0	1.0
2	1.0	1.4	1.8	2.0
3	2.0	2.1	2.5	3.1
4	2.1	2.3	2.8	3.9

Then the home-based work trip production was derived for each TAZ by multiplying the household matrix by the trip rate matrix and summing the products in the matrix. The home-based work trip production for Ada County, for example, was 167,721.

The same procedure was followed to generate trip productions for home-based shopping, home-based school, and home-based other for each county.

2. Nonhome-based productions

The linear regression equation for nonhome-based trip production was:

$$1.1428 \text{ Retail Employment} + 1.4846 \text{ Non-Retail Employment} + 0.2969 \text{ HH}$$

3. Trip attractions

The trip attractions were derived from the following linear regression equations:

HBW Attractions	= 1.8361 Total Employment
HBO Attractions	= 1.1788 Total Employment + 2.1432 HH
HB School Attractions	= 7.1350 School Employment
HB Shop Attractions	= 6.1147 Retail Employment
NHB Attractions	= NHB Productions

External trip generation

It is assumed that the trip productions and attractions of external stations had the same characteristics as those of internal trip productions and attractions. First, the proportion of the internal productions and attractions by trip purpose were calculated. The proportions were: HBW 0.23, HBSH 0.14, HBSC 0.08, HBOT 0.36, NHB 0.19. Then, the traffic counts on the links of external entries were multiplied by the above proportions. Finally, the auto trips were multiplied by 1.7356 to convert them to person trips.